AD-A045 180 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO F/G 15/3

U. S. STRATEGIC DOCTRINE AND THE DEVELOPMENT OF COMMAND AND CON--ETC(U)

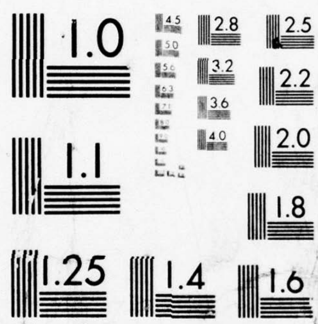
APR 75 F G KLOTZ

UNCLASSIFIED AFIT-CI-77-3 NL

1 OF 2

AD

A045180



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

U.S. STRATEGIC DOCTRINE
AND THE DEVELOPMENT OF
COMMAND AND CONTROL SYSTEMS

by

Frank G. Klotz
1Lt, USAF

77-3T

1

U.S. STRATEGIC DOCTRINE AND THE DEVELOPMENT

OF COMMAND AND CONTROL SYSTEMS

by

Frank G. Klotz

Trinity College

submitted for the

Bachelor of Philosophy Degree in International Relations

Oxford University

April 1975

ACCESSION for		
NTIS	White Section	X
DDC	Buff Section	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	AVAIL. and/or SPECIAL	
A		

D D C

RECEIVED

OCT 14 1977

D

DISTRIBUTION STATEMENT A

Approved for public release;

Distribution Unlimited

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

ok

1. REPORT NUMBER: CI 77-3

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER: 14 AFIT-CI-77-3

4. TITLE (and Subtitle): 6 U. S. Strategic Doctrine and the Development of Command and Control Systems,

5. TYPE OF REPORT & PERIOD COVERED: Thesis

6. PERFORMING ORG. REPORT NUMBER

10

7. AUTHOR(s): FRANK G. KLOTZ

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS: AFIT Student at Oxford University, England

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS: AFIT/CI, Wright-Patterson AFB OH 45433

12. REPORT DATE: 11 Apr[illegible] [illegible]75

13. NUMBER OF PAGES: ~~146~~ pages 12 170p.

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Jerral F. Guess

JERRAL F. GUESS, Captain, USAF
Director of Information, AFIT

APPROVED FOR PUBLIC RELEASE AFR 190-17.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Attached

ok

012 200

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(*When Data Entered*)

SECURITY CLASSIFICATION OF THIS PAGE(*When Data Entered*)

ABSTRACT

Name: Klotz, Frank G., 1Lt, USAF
Title: U.S. Strategic Doctrine and the Development of Command and Control Systems
Date: 1975
Institution: Oxford University, England
Degree: Bachelor of Philosophy in International Relations

In January 1974, Secretary of Defense James R. Schlesinger confirmed that the American Administration intended to insure that the U.S. strategic nuclear forces were capable of conducting limited and highly discerminatory attacks in the event of a major war. In subsequent statements, Secretary Schlesinger further indicated that the most important technical constraint in providing for such flexibility in the employment of strategic nuclear forces was their associated command and control systems.

This study identifies and discusses the broad categories of command and control functions which are generally considered to be necessary for the implementation of a highly selective nuclear strategy. These include tactical warning, attack assessment, and the specific direction of particular elements of the strategic nuclear forces. Then, the command and control systems capable, to some extent, of performing these functions are identified and discussed, with particular reference to the rationales which underlay the original decisions for their respective development. Included in this discussion are the various early warning systems, the Strategic Air Command Command and Control System (SACCS), the Command Data Buffer System, the several Fleet Ballistic Missile (FBM) communication systems, and the components of the National Military Command System (NMCS).

This study concludes that the present generation of strategic command and control systems were not, for the most part, originally designed to meet the requirements for the implementation of a highly selective nuclear strategy. Nevertheless, the technical characteristics which were ultimately incorporated into these systems endowed them with many of the command and control capabilities specifically associated with such a strategy. Cuurent Air Force, Navy and Defense Department programs indicate considerable emphasis is now being placed on enhancing these capabilities as well as developing new systems, such as the Advanced Airborne Command Post.

Acknowledgements

The preparation of this study would have been rendered virtually impossible without the kind and generous support of a number of individuals to whom I am deeply indebted. I am more grateful than I can adequately acknowledge to Colonel Joseph W.Bullers, who is currently the Military Assistant for Strategic Command and Control Systems in the Special Programs Office of the Director, Telecommunications and Command and Control. Colonel Bullers not only consented to discuss with me many of the observations he has derived from his long experience and involvement with command and control issues, but also greatly assisted my research efforts by arranging many of the interviews that I conducted in Washington and by continuing to direct me to the more significant unclassified literature on command and control throughout the course of my research. Dr. Al. Goldberg, the Chief Historian for the Secretary of Defense, also suggested the names of individuals to interview, and provided me with some very useful advice concerning the methods and procedures associated with the research of topics concerning American defense policy.

No graduate student could long survive without the help of the benevolent librarian. I am especially thankful to Mrs. Meryl Eady, Librarian for the International Institute for Strategic Studies, for her assistance. I am also extremely grateful to the staff of the U.S. Air Force Academy Library and to its director, Lt. Col. Claude Johns for granting me permission to use the resources and facilities of the Academy Library, as well

as providing me pleasant and familiar surroundings in which to work.

In the way of academic supervision, my degree supervisor, Mr. Wilfrid Knapp, Fellow of St. Catherine's College, and Professor Michael Howard, Fellow of All Souls College, were particularly helpful in supplying me with their important advice regarding possible approaches which could be taken in a project such as this. By far the greatest debt I owe is to my thesis supervisor, Mr. Lawrence Freedman, Research Fellow of Nuffield College, who not only suggested in the first place that command and control might be an interesting topic to examine, but also gave generously of his time to provide guidance and incisive criticism for the whole of my research and writing.

As ever, I am also grateful to my wife, Nancy, who typed the earlier drafts of this study and, perhaps most importantly, lent her seemingly limitless moral support to my work.

Needless to say, any errors or shortcomings in this study are attributable only to me.

A Note on Sources

Since it directly affects the manner and the extent to which the U.S. would be able to manage the operations of its strategic nuclear forces in the event of a major crisis or war, command and control is perhaps one of the most sensitive subjects related to the current U.S. military force structure. Indeed much of the information pertaining to the characteristics and capabilities of the U.S. strategic command and control systems has been highly classified by the Department of Defense. This study is, however, restricted to a discussion of the unclassified aspects of the subject, and, to this extent, must be considered somewhat inherently limited in its approach.

This limitation should not be considered as an insurmountable barrier to reasonably detailed and comprehensive understanding of the issues related to command and control. One of the characteristics of the American social system is the amount of information regarding ostensibly sensitive military subjects which is in fact available in the so-called "open literature". Such information is found in the form of newspaper articles, reports in scientific and military journals, and official government documents which have been released to the public. The perusal of such literature often yields a fairly comprehensive, if not complete, appreciation of the issues involved with certain classified subjects.

The information and arguments presented in this study have been derived primarily from such unclassified material. No classified reports or documents were used in the writing of this study.

This study also benefitted from the information and insight provided in a series of 26 interviews with past and present Air Force, Army, Navy and Defense Department officials which were personally conducted by the author. At the outset of each interview, the author explicitly informed each interviewee that the study being conducted was strictly unclassified, that the information was intended for inclusion in an academic thesis, and that the author did not wish to receive or discuss classified information. To the best of the author's knowledge, the interviewees did not divulge any classified information. Several interviewees specifically requested that their names not be identified in the text of this study. For the sake of uniformity and fairness to all of the individuals who contributed so kindly to this research effort, none of the names of the interviewees are included in this study. At several points in this study references are made to particular interviews as the source of certain information. In such cases the relevant footnote will indicate the number the author has assigned to the interview in which that information was obtained. The author is willing to discuss any comments or questions regarding the validity or authenticity of any information referenced in this manner.

Finally, it should be noted that the author is an American officer, still on active duty with the U.S. Air Force, and has held both Secret and Top Secret security clearances. However, at no time during his service in the Air Force has he had an assignment or received any training which involved access to or use of any classified information regarding the issues discussed in this study. Furthermore, the views expressed in this study are strictly the author's own and should not be construed

as necessarily representing the official policy of the U.S. Air Force or the U.S.Government.

TABLE OF CONTENTS

INTRODUCTION

In January 1974, the American Secretary of Defense, Dr. James R.Schlesinger, announced to a meeting of the Overseas Writers Club in Washington that the United States had begun retargetting some of its strategic missiles so that they could strike at Soviet military installations as well as Soviet cities. Somewhat surprisingly perhaps, Secretary Schlesinger's announcement does not appear to have made an immediate impact on the general public. The New York Time's coverage of the story, for example, was found only on page six of its January 11 edition.[1] However, as the change in U.S. strategic nuclear doctrine which Secretary Schlesinger's remarks had reported was further defined and explained in subsequent testimony by Defense Department officials, a major debate concerning the implications and relative merits of the new doctrine emerged among members of the government and academic communities with a particular interest in strategic issues. The debate itself was enjoined in a wide variety of magazines and journals, as well as in American television discussion programmes.[2] Indeed, the reprinting of an earlier article by Barry Carter critiqueing the so-called "Schlesinger strategy" in the January-February 1975

---

1 New York Times, January 11, 1974, p.6.

2 For example, Barry Carter, "Nuclear Strategy and Nuclear weapons", (Scientific American, April 1974); Michael T. Klare, "Making Nuclear War 'Thinkable'," (The Nation, April 13 1974); Edward N.Luttwak, "Nuclear Strategy: The New Debate," (Commentary, April 1974); William C. Moore, "Counterforce: Fact and Fantasies," (Air Force Magazine, April 1974); and, Herbert Scoville, Jr., "Flexible Madness?" (Foreign Policy, Spring 1974).

issue of Survival suggests that the debate is still very much alive.[1]

By the summer of 1974, the debate had assumed sufficient dimensions that at least one effort was made to identify and clarify its often conflicting themes and points of contention. In the July 1974 edition of Foreign Affairs, Ted Greenwood and Michael Nacht argued that the debate had actually begun with the publication of an article by Dr. Fred Ikle entitled "Can Deterrence Outlast the Century," in the January 1973 Foreign Affairs. Dr. Ickle's article seriously questioned the rationality of basing deterrence on the threat of automatic and massive retaliation on enemy cities given the finite possibility that deterrence might somehow fail.[2] Since early 1973 then, according to Greenwood and Nacht, the debate concerning doctrine has involved six fundamental issues:

> "....The first deals primarily with targetting flexibility and concerns the relationship between increasing the likelihood of nuclear war and improving its controllability. The second focuses on the extent to which improving counterforce capability is equivalent to the pursuit of a disarming first strike capability. The third deals with the arms race. The fourth addresses the feasibility of conducting limited nuclear war. The fifth concerns the effect of nuclear options on the credibility of the American security guarantees to our allies. The sixth deals with the question of whether advances in Soviet nuclear flexibility require comparable measures by the United States."[3]

---

1 Carter, op.cit. Reprinted in Survival, January/February 1975, pp 25-31.

2 Fred Charles Ickle, "Can Nuclear Deterrence Last Out the Century," (Foreign Affairs, April 1974) pp 267-285.

3 Ted Greenwood and Michael T.Nacht, "The New Nuclear Debate: Sense or Nonsense?" (Foreign Affairs, July 1974) p 765.

The fourth area of debate - issues regarding the feasibility of conducting limited nuclear war - might in fact be divided into two additional and separate areas of inquiry. The first could be described as the pyschological and questions whether national decision-makers would, in the midst of a nuclear crisis, be able to maintain a rational perspective of the situation and to make the kinds of decisions which would be necessary to keep a limited war limited and prevent its escalation to a total, general war.[1]

A second area of inquiry which might be subsumed under the general question of the feasibility of limited nuclear war considers the technological dimension and questions whether the technical characteristics of the strategic nuclear forces allow those forces to be used in the manner suggested by a doctrine of strategic nuclear flexibility. For the most part, the literature which has dealt with the technological aspects of the current debate has focused primarily on the characteristics of the actual weapons themselves - including such issues as warhead accuracy, missile throw weight, warhead weight-to-yield ratios, etc.[2]

One element of the technological aspect of the current debate over strategic nuclear doctrine which has largely been ignored, or only briefly discussed, in the open literature concerns

---

1 The psychological dimension of waging limited strategic war is discussed in Herman Kahn, On Thermonuclear War, (Princeton: University Press, 1961) and in Klaus Knorr and Thornton Read (ed.) Limited Strategic War, (London: Pall Mall Press, 1962).

2 For example, Carter, op.cit.

the issue of the command and control of the strategic nuclear forces. Since the term "command and control" will be defined in greater detail in a later chapter, it suffices to note at this point that command and control refers to the means by which decisions regarding the use of forces are made and subsequently transmitted to those forces. The lack of detailed analysis and discussion of command and control in the current debate cannot be attributed to any relative lack of significance of command and control to the issue of strategic nuclear doctrine. On the contrary, since command and control capabilities directly determine the manner in which forces can actually be employed, they are highly relevant to any doctrine which suggests the way in which the national decision-makers would want to employ those forces in the event of a nuclear war.

This point has been made quite clearly by Secretary Schlesinger. In March 1974, he discussed the new strategic doctrine in testimony before a subcommittee of the Senate Foreign Relations Committee. The following exchange has been recorded between Senator Stuart Symington (D-Mo.) and Schlesinger:

> "Senator SYMINGTON. At this time which do you believe would be more limiting to the flexibility of the U.S. strategic responses, the constraints of our command and control system, including the inflexibility of our computer hardware and software, or the basic hardware components of our effective weapons themselves?
> Secretary SCHLESINGER. The former, sir."[1]

---

1 U.S. Congress, Senate, Subcommittee on Arms Control and International Law and International Organizations of the Committee on Foreign Relations, U.S.-U.S.S.R. Strategic Policies, March 4, 1974, p 24.

In addition to a relative lack of attention on command and control issues in the current public debate on strategic nuclear doctrine, command and control has likewise not been subjected to any extensive study or analysis in the more academic literature regarding strategic studies. In the late 1950s and early 1960s, the theoretical relationships between command and control and alternative strategies were examined and this examination is reflected in several of that period's seminal works on strategic issues - including Herman Kahn's On Thermonuclear War and Klaus Knorr and Thornton Read's Limited Strategic War. Perhaps the fullest theoretical treatments of command and control itself were provided by Read's 1961 Princeton study memorandum entitled Command and Control and Herbert Benington's "Command and Control for a Selective Response", which was printed in the Knorr and Read anthology. However, since this earlier period of interest and concern about command and control very little has been written of an academic nature about the relationship between command and control and strategic nuclear doctrine, although the issue has been sporadically discussed in several more technical industrial and military journals.[1]

Furthermore, no comprehensive academic study concerning the actual U.S. command and control systems - including their characteristics and respective development programmes - has yet been conducted. This paucity of academic analysis of command and control technology is particularly surprising when one considers the number of excellent studies which have been

---

1 Articles concerning command and control issues appear regularly (usually in special annual editions) in such journals as Air Force Magazine, Signal, and, until 1969, Armed Forces Management.

devoted to the history of the research and development programmes of other U.S. military weapons systems.[1]

Nevertheless, given the central importance of command and control to the issue of strategic nuclear doctrine, an understanding of the fundamentals of command and control is indispensable for a comprehensive understanding of the new strategic debate. This study is based on this assumption. Its purpose can thus be described in terms of three overlapping and complementary objectives. The first is to provide a description and history of the strategic command and control systems which have been developed in the United States since the Second World War, particularly those which affect the flexibility with which the strategic forces can be employed. The second objective is to examine the nature of the relationship between command and control and strategic nuclear doctrine which has been referred to by Secretary Schlesinger.

The third objective is to determine the extent to which considerations of strategic nuclear doctrine, particularly the issue of strategic nuclear flexibility, have determined the direction of command and control developments. It will be argued in the course of this study that strategic nuclear flexibility was not a major factor in influencing the outcome of the vast majority of command and control development programmes

---

1 For example, Michael H. Armacost, The Politics of Weapons Innovation: The Thor-Jupiter Controversy, (New York: Columbia University Press, 1969); Robert J. Art, The TFX Decision: McNamara and the Military, (Boston: Little, Brown and Company, 1968); Richard G. Head, "Decision-Making on the A-7 Attack Aircraft Program", (D.P.A. dissertation, Syracuse University, 1971); Harvey Sapolsky, The Polaris System Development, (Cambridge (Massachusetts): Harvard University Press, 1972); Edward R. Jayne, "The ABM Debate", (Ph.D. dissertation, Massachusetts Institute of Technology, 1969).

prior to 1970. Rather, most of these programmes were justified and pursued for other reasons, which will be identified. Yet, whatever the respective rationales for each of these systems, the technology which was employed in their construction has nevertheless endowed them with many of the technical capabilities which have been associated with the command and control requirements of engaging in a limited strategic nuclear war.

Consideration of the purposes and objectives of this study to a large extent suggests the actual approach which will be taken. The first chapter is intended to provide a brief historical outline of the development of strategic nuclear doctrine in the United States, with particular emphasis on the trend toward increasing emphasis on strategic flexibility which first officially manifested itself when Robert S.McNamara became Secretary of Defense in 1961. This examination focuses on the way in which doctrine suggests that the U.S. strategic nuclear forces would be employed in the event of a nuclear war with the Soviet Union (or, presumably any other nuclear power). This discussion is not intended to provide a comprehensive or definitive account of the various domestic and international political factors or the specific decisions which may have led to changes in doctrine. Neither will it explore the full range of implications of any particular change. Rather, this chapter simply seeks to highlight those features of doctrine which are necessary for an understanding of the relationship between strategic doctrine and command and control.

The second chapter serves as an introduction to the subject of command and control itself, including a basic definition of

the term, as well as a brief sketch of the nature of the command and control process prior to the development of nuclear weapons. The impact of these weapons upon traditional notions of command and control is then discussed. Finally, the theoretical relationship between command and control and particular strategic nuclear doctrines is examined.

The following three chapters discuss the characteristics and development of the actual U.S. strategic command and control systems in terms of the theoretical framework suggested by Chapter Two. Of necessity, the discussion in these chapters often makes reference to somewhat technical information. The relationship between strategic doctrine and command and control is ultimately a question of whether or not the existing command and control systems can perform the particular command and control functions which are implied by the doctrine. To fully answer this question requires at least some analysis of the actual capabilities of the strategic command and control systems and such an analysis will inevitably be somewhat technical in nature. Not surprisingly perhaps, the analysis of any strategic concept in the nuclear age is in jeopardy of falling unhappily somewhere in between the metaphorical "two cultures". From the perspective of the historian and the student of politics, a study of strategic concepts may seem to dwell too much on the technical aspects involved. The scientist, on the other hand, may well contend that important technical details have received only cursory attention. This study strives for the middle ground, discussing primarily those technical factors which are essential for a reasonable understanding of the relationship between command and control and strategic nuclear doctrine.

Even if it is successful in achieving its objectives, this study will still leave a great deal about the vast and often complex field of command and control unsaid. For example, the command and control of conventional and tactical nuclear forces, the command and control of inter-allied (i.e., NATO) operations, command and control as an aspect of the broader questions of centralized civilian control over military operations and nuclear safety, and the nature of Soviet command and control are all vital aspects of the larger subject but do not fall under the purview of this study. Although these questions involve many of the same principles discussed in this study and share many of the same problems with strategic command and control, they nevertheless can be considered to represent separate areas of inquiry.

This study will in the end, it is hoped, provide for an understanding of a highly complex set of strategic relationships and systems. The subject of command and control has for so long largely been the exclusive domain of the technologist and the professional analyst, as most scholarly analyses of the American defense policy have tended to concentrate on the more visible and the more dramatic aspects of contemporary strategic issues. The subject of command and control, as this study will demonstrate, lies close to the centre of virtually every strategic issue, and for this reason properly constitutes a legitimate focus for academic research and discussion. The following study is intended as a contribution to such research and discussion.

CHAPTER ONE

Strategic Nuclear Doctrine: The Trend Toward Increased Flexibility

The Massive Retaliation Doctrine

Prior to the early 1960s, U.S. strategic nuclear doctrine was primarily defined in terms of the doctrine of massive retaliation. The doctrine itself was first formally articulated by Secretary of State John Foster Dulles in January 1954. Dulles' remarks at that time were specifically intended to address the means by which the United States could militarily deter Communist aggression. At the time of Dulles' announcement, the threat of Communist aggression against U.S. interests was considered by U.S. policy makers to be the most immediate in Wetern Europe or in the so-called "peripheral areas." The solution to the problem of deterrence enunciated by Dulles was for the United States to maintain the capability to retaliate against any such agression "...by the means and the places of our own choosing."[1] The means presumably involved taking advantage of the clear U.S. superiority in nuclear weaponry rather than again becoming involved in the expense and frustration of the kind of military response represented by the

---

1 Quoted in John Foster Dulles, "The Doctrine of Massive Retaliation", in Richard G.Head and Ervin J.Rokke, (ed.), American Defense Policy (3rd ed.) (Baltimore: The Johns Hopkins University Press, 1973), p 63.

Korean War. The massive retaliation doctrine in effect extended a "nuclear umbrella" to those nations allied to the United States.

While Dulles' remarks had been primarily concerned with the problem of local aggression, the development of Soviet intercontinental range bombers and missiles throughout the 1950s ultimately brought the United States itself within the range of a direct Soviet attack. Just what the massive retaliation doctrine suggested would be the U.S. response to such an attack had in fact been foreshadowed by General H.H.Arnold, commander of the Army Air Forces, as early as November 1945:

> "...With the continued development of weapons and techniques known to us, New York, Pittsburgh, Detroit, Chicago, or San Francisco may be subject to annihilation from other continents in a matter of hours...(the United States) must recognize that real security against atomic weapons in the future will rest on our ability to take immediate offensive action with overwhelming force. It must be apparent to the potential aggressor that an attack on the United States would be immediately followed by an immensely devastating air-attack upon him."[1]

The massive retaliation doctrine suggested, as had General Arnold, that the U.S. response to a Soviet attack upon the United States would result in an immediate and massive counter-attack against Soviet cities and industrial centres (counter-value targets) as well as Soviet military installations (counter-force targets) in an effort to destroy the Soviet Union as a viable society.

---

1 Quoted in Louis J.Halle, The Cold War as History, (New York: Harper and Row, Publishers, 1967), pp 174-5.

For most U.S. policy-makers the stated purpose of declaring this strategy of a drastic, "spasm" response was, in the words of Dulles, to achieve "...maximum deterrence at a bearable cost".[1] If the U.S. could be expected to launch an all-out nuclear attack in response to a nuclear attack upon the U.S., the logic of deterrence suggested that no rational enemy would be willing to initiate an attack in the first place since any advantages which might accrue from striking first would be far outweighed by the losses which would subsequently result.

From the very beginning of its articulation, the massive retaliation doctrine never commanded universal support. Not surprisingly criticism of the doctrine as a means of deterring or engaging in a nuclear war had begun well before the 1960s. For example, NSC-68, the product of a joint State-Defense Department study under the direction of Paul Nitze, had argued as early as 1950 against reliance on a single military strategy to deter Soviet or Communist aggression.[2] Within the Pentagon, debate concerning the relative merits of the massive retaliation doctrine assumed many of the characteristics of more traditional interservice rivalry. For example, after having lost its bid for a share of the offensive strategic nuclear role, the Army began to restate the case for conventional force capabilities both to deter

---

1 Dulles, op,cit. p. 63.

2 Morton H.Halperin, Contemporary Military Strategy, (2nd ed.) (London: Faber and Faber, 1972), p. 40.

and combat Communist agression.[1] The Air Force, which for the most part was dominated by the Strategic Air Command at that time, continued to adhere to the precepts of the massive retaliation doctrine as adumbrated by General Arnold in 1945. However, several Air Force officers had begun to study and then to advocate a so-called "counter-force" or "war-fighting" doctrine, which conceived of strategic nuclear war fare in the more traditional military convention of forces attacking other forces instead of population centres.[2]

The issue of alternative war strategies also became a topic of considerable debate among academicians and civilian defense analysts - particularly those employed by the RAND Corporation and other research organizations closely affiliated with the Defense Department - during the latter half of the 1950s. Significantly, the strategic studies literature of this debate also drew considerable attention to the importance of command and control capabilities to any discussion of nuclear war strategy, and included the first systematic analysis of the problems associated with command and control in the nuclear age.[3] The impact of the critique of the massive retaliation

---

1 An analysis of the Army's bid for a strategic nuclear role is found in Michael J.Armacost, The Politics of Weapons Innovations: The Thor-Jupiter Controversy, (New York: Columbia University Press, 1969). The Army's subsequent case for an increased conventional warfare capability is presented, for example, in Maxwell D.Taylor, The Uncertain Trumpet, (New York: Harper and Brothers, Publishers, 1959).

2 Richard Fryklund, 100 Million Lives,(New York: The MacMillan Company, 1962), pp 18-39.

3 For example, Herman Kahn, On Thermonuclear War, (Princeton: Princeton University Press, 1961) and Klaus Knorr and Thornton Read, Limited Strategic War, (London, Pall Mall Press, 1962).

doctrine by such strategic theorists as Herman Kahn and Bernard Brodie, as well as more traditional academicians, such as Henry Kissinger, on the actual formulation of policy in the Sixties would prove to be quite considerable.[1] By the time McNamara became Secretary of Defense for the newly-elected President Kennedy in January 1961, the necessary intellectual groundwork had been laid for a fundamental revision of U.S. strategic nuclear doctrine.

The Selective Response Doctrine

Perhaps somewhat surprisingly, the individual who would supply much of the impetus to the changing of the U.S. strategic doctrine had had very little exposure to the strategic issues or debates of the day. According to one observer, McNamara had read only one recent book related to defense policy - Oskar Morgenstern's The Question of Defense.[2] Despite any lack of familiarity with the subject, McNamara immediately concerned himself with studying the facts and issues involved. As part of a general review of the U.S. defense posture which had been

---

1 For example, Rosswell Gilpatrick, Deputy Secretary of Defense from 1961 to 1964 wrote that it "...was the earlier period of study and debate which made it possible for the new (Kennedy) administration to move forward with its defense programs with speed and confidence in 1961. Issues such as survivability, non-nuclear options, and controlled response had been extensively examined for several years prior to 1961." Rosswell L.Gilpatrick, "Our Defense Needs the Long View," (Foreign Affairs, April 1964), p. 375.

2 Interview No 12.

requested by President Kennedy, McNamara and his staff submitted a long series of specific questions to various Pentagon agencies in order to elicit their remarks and suggestions regarding particular issues. Several of these so-called "trombones" specifically addressed nuclear war doctrine, including the issue of a survivable and responsive command and control system.[1]

The major objection to the doctrine of massive retaliation subsequently voiced by McNamara and his advisors specifically concerned the number of options which it supposedly afforded the President in the event of a war with the Soviet Union. As was stated above, the primary purpose of the doctrine was to deter Soviet attack against the United States or those areas considered to be included under the U.S. "nuclear umbrella". But translated into an actual war-fighting strategy should this deterrence fail, the massive retaliation doctrine, according to McNamara, afforded the President only two options - namely, to do nothing or to launch an unrestrained, massive nuclear attack against the Soviet Union. Kissinger, for one, had earlier referred to this situation as a "choice between Armageddon and defeat without war."[2]

The academic literature of the Fifties was, however, replete with scenarios in which a massive, spasm response to a Soviet attack upon the United States or any of its allies could

---

1 Alain C.Enthoven and K.Wayne Smith, How Much Is Enough?: Shaping the Defense Program, 1961-1969,(New York: Harper and Row, 1970), pp 172-3. Also, Interview No. 12.

2 Henry A.Kissinger, Nuclear Weapons and Foreign Policy, (New York: W.W.Norton and Company, 1969), p 112.

not be considered the most rational course of action for the U.S. to take.[1] For example, several strategists argued that since recourse to nuclear war would probably involve massive destruction to the U.S., the credibility of the U.S. nuclear guarantee against conventional attacks in Western Europe was highly questionable. A capability to defend the U.S. allies against a conventional attack with conventional forces might prove to be a more credible deterrent, as well as a less destructive option should deterrence fail. In the event that nuclear attacks were actually launched against the United States, it was presumed that the U.S. would not want to engage in the wholesale destruction of the Soviet Union if the Soviet "attack" only involved the launching of a small number of missiles by accident or as a result of the unauthorized action on the part of a lower echelon commander. Similarly, the U.S. would probably want to refrain from launching a massive retaliatory strike if the Soviets had attacked only a single or a very limited number of U.S. targets in order to demonstrate the seriousness of their demands or the extent of their resolve regarding a particular issue. Likewise, the U.S. would be inviting disaster if it attacked Soviet counter-value targets in response to a Soviet first-strike which had limited itself to attacking U.S. military targets and had left enough forces in reserve to destroy U.S. cities should the U.S. decide to retaliate against Soviet cities. Whatever the scenario envisioned by the literature, the conclusion was usually the same - namely, in the event of an actual

---

1 For example, ibid., as well as Kahn, op.cit. and Knorr and Read, op.cit.

war with the Soviet Union, the United States decision-makers might wish to have more strategic options available than those which were implied by the massive retaliation doctrine. Rather, it was argued, that the U.S. strategic response should be tailored to the specific situation, particularly the character and nature of the Soviet attack.

The strategic doctrine adopted almost immediately by the Pentagon under McNamara's direction was called flexible, or controlled response. The stated purpose of the doctrine was to allow the President to choose from among several options in the event of a Soviet attack, depending upon the circumstances at the time of his decision. The strategy of flexible response was not, however, restricted to the special case of strategic nuclear warfare, but was intended to apply to all levels of military conflict in which the U.S. or its allies might be involved. The doctrine was predicated on the fear that the Soviet Union or other Communist movements might engage in actions which militarily undermined U.S. or allied interests, but which might not clearly be defined as aggression - such as subversion or guerrilla warfare. General Maxwell Taylor and other proponents of the flexible response doctrine argued that the nuclear response suggested by the massive retaliation doctrine would not be appropriate as a deterrent or effective counter to such tactics.[1] The flexible response doctrine suggested instead that the U.S. should have enough military options available to be able to respond at a level appropriate to the actual

---

1 Taylor, op.cit., pp 130-164.

threat. Thus, insurgency warfare should be met with counter-insurgency warfare, conventional attacks should be met with conventional forces, limited nuclear attacks should be answered with similarly limited nuclear attacks.

The subject of this study, however, specifically concerns strategic nuclear doctrine. Since the flexible response doctrine, as articulated by its advocates, entails both conventional and strategic operations, for the purposes of clarity, the concept of flexibility as it applies to strategic nuclear warfare will be referred to in this study as the selective response doctrine, as is the case in a number of other studies.[1]

With respect to strategic nuclear war, McNamara was primarily interested in including one additional option within the context of the U.S. strategic nuclear war contingency plans. This option has variously been described as the "counter-force" or "no-cities" doctrine. William Kaufmann, who was a major participant in the formulation of this doctrine as a special consultant to McNamara, has described counter-force in the following terms,

> "...(it) rested on several premises. The first was that there were circumstances in which deterrence might not work. The second was that the number of lives which would be lost in a thermonuclear war would vary significantly, depending, among other factors, on the types of targets attacked by the belligerents. The third was that limiting damage to the United States and its allies would constitute a major wartime objective, and that it could best be done by attacking the enemy's bombers and missiles and by providing active and civil defense for American and allied populations. The fourth and

---

1 For example, Knorr and Read, op.cit.

related premise was that the combination of avoiding enemy cities and holding forces in reserve would provide the enemy with incentive to confine his own attacks to American or Allied military targets and thus contribute further to the limitation of damage...Finally, there was the premise that even a thermonuclear conflict would not totally erase the interest of the United States in the post-war world; hence, sufficient forces should be available to eliminate or neutralize residual enemy capabilities, bring the war to conclusion, and provide a measure of protection thereafter."[1]

As such, counter-force was often popularly taken to imply a return of strategic nuclear warfare to the battlefield. In his June 1962 address to the graduating class of the University of Michigan in Ann Arbor, McNamara remarked that,

"...to the extent feasible basic military strategy and a possible general war should be approached in much the same way that more conventional operations have been regarded in the past. That is to say, the principle military objective, in the event of nuclear war stemming from a major attack on the allies should be the destruction of the enemy forces, not his civilian population.[2]

McNamara lost little time in incorporating the necessary changes in the U.S. contingency plans for strategic nuclear war to provide for a selective response strategy which included an option for a counterforce attack. On March 6, 1961, the Joint Chiefs of Staff were ordered to prepare a doctrine that would allow for a controlled response to a Soviet attack with the possibility of interwar negotiations.[3] Accordingly, a new

---

1 William W.Kaufmann, The McNamara Strategy, (New York: Harper and Row, Publishers, 1964), pp 44-5.

2 Robert S.McNamara, "Defense Arrangements of the North Atlantic Community", (Department of State Bulletin, July 9 1962) p 67 .

3 Desmond V.Ball, "The Strategic Missile Program of the Kennedy Administration, 1961-1963", (Unpublished PH.D. thesis, Australian National University, 1972), p 278.

strategic policy was drawn-up in which Soviet strategic forces were separated from cities on U.S. target lists, strategic reserves were to be held in accordance with concepts of interwar negotiations, U.S. command and control systems were to be protected to allow for a controlled response, and Soviet command and control systems were not to be attacked, at least initially.[1] Since August 1960, the compilation of targets to be attacked in the Soviet Union in the event of a general war has been the responsibility of the Joint Strategic Target Planning Group (JSTPG) composed of both Naval and Air Force officers under the direction of the commander of SAC. The JSTPG had been created by Secretary of Defense Gates largely to defuse arguments by the Strategic Air Command that it be given the responsibility for the entire strategic nuclear mission. The function of JSTPG is to continually review the U.S. target lists to insure that forces are pre-assigned to each potential enemy target, without unnecessary duplication of effort by SAC and Navy forces.[2] The efforts of the JSTPG are incorporated in the Single Integrated Operations Plan (SIOP), which, in very general terms, lists the actual targets to be attacked and the specific forces which are to attack them.

Prior to 1961, the SIOP had apparently provided for the exercise of only one strategic option - namely a massive undifferentiated strike against Soviet cities, industry, and military installations. However, under the direction of McNamara, the number of options contained in the SIOP

---

1 *ibid*.

2 *Time*, August 29, 1960, p 15.

were expanded to five (with various sub-options), including: attacks on Soviet strategic forces, attacks on air defenses away from cities, attacks on Soviet command and control capabilities, and, if necessary, an all-out massive attack against Soviet population and industrial centres.[1] The new SIOP was reportedly adopted in January 1962. Thus, in March of that same year, McNamara was able to announce that the necessary steps had been taken to insure that the U.S. response to a Soviet attack on the U.S. "...will be graded by degree, by geographical and political area, and by target type as would be appropriate to the type and extent of an enemy attack."[2]

The counter-force option was considered by McNamara to be but one option within a larger matrix of strategic nuclear options among which the national decision-makers could choose, depending upon the circumstances which existed at the time of a nuclear war. In response to what he considered to be an inordinate emphasis on the counter-force aspects of the new doctrine, McNamara at one point replied that,

> "...I carefully qualified what I said, and I made it clear that this counterforce was only one of a series of options. I would want to be absolutely certain that we had other options."[3]

Nevertheless, the counter-force option received considerable

---

1 Ball, op.cit., p. 278.

2 "Statement of the Secretary of Defense Robert S.McNamara on the RS-70", quoted in Gordon H.Evans, "The New Military Strategy", (Current History, August, 1964), p. 77.

3 Quoted in an interview by Stewart Alsop, "McNamara Thinks About the Unthinkable", (Saturday Evening Post, December 1, 1962), p. 18.

attention throughout 1961 and 1962, both within the Pentagon and the ensuing public debate concerning the new doctrine.

After 1963, however, McNamara began a very discernible shift away from the almost exclusive emphasis on counter-force which had characterized his public comments on strategic nuclear doctrine during the previous two years. For example, in January 1963 McNamara had testified before the House Armed Services Committee that,

> "... the major mission of the strategic retaliatory forces is to deter war by their capability to destroy the enemy's war-making potential, including not only his nuclear strike forces and military installations, but also his urban industrial society, if necessary."[1]

But in February 1965 he stated before the same committee that "...the vital first objective, to be met in full by our strategic retaliatory forces, is the capability for assured destruction," which he defined as "...the capability to destroy the aggressor as a viable society even after a well planned and executed surprise attack against our forces".[2] In this same testimony, the counter-force concept was subsumed under the generic term "damage limitation", which referred to both offensive and defensive measures to "blunt" an enemy attack and thereby afford some degree of protection to the U.S. Thus, in the period of two years the doctrine of counter-force had been shifted from a primary to a secondary emphasis. The concept of assured

---

1 Quoted in "McNamara: A Change in Policy?" (Bulletin of the Atomic Scientists, April 1963), p 37.

2 Robert S.McNamara, "General Nuclear War: Assured Destruction and Damage Limitation", in Mark E.Smith and Claude J.Johns, Jr., American Defense Policy, (2nd ed.) (Baltimore: The Johns Hopkins University Press, 1968), p 98.

destruction was thereafter accorded primary emphasis. While the stated purpose of this concept was ostensibly to determine the optimum size of the U.S. strategic forces by defining the amount of damage they should be able to inflict on the Soviet population and industry, the doctrine nevertheless reinforced the "counter-value" aspects of the U.S. targetting doctrine precisely because of its explicit reference to the destruction of Soviet population and industry.[1]

Regardless of any change in emphasis, McNamara had by 1962 effected some lasting changes in the strategic nuclear options available to the U.S. decision-makers in the event of a nuclear war with the Soviet Union. As Secretary Schlesinger would verify some years later, options which would allow for the selection of a counter-force strike, a counter-value strike, or some combination of the two had become a permanent feature of the SIOP.[2] Thus the emphasis on assured destruction which characterized the public pronouncements of Pentagon officials after 1963 represented a shift in declaratory doctrine rather than a change in the actual U.S. targetting policy.

After 1968, the issue of strategic nuclear flexibility continued to be discussed in the public statements of Defense Department officials, albeit in less enthusiastic terms than the previous two years. According to Secretary Schlesinger in 1974,

---

1 This point has also been made in Greenwood and Nacht, op.cit., p 763.

2 U.S. Department of Defense, Report of the Secretary of Defense James R.Schlesinger to the Congress on the FY 1975 Defense Budget and the FY 1975-1979 Defense Program, March 4, 1975. (Note: In future, the annual reports of the Secretary of Defense will be referenced in the following manner: Department of Defense, Annual Report, (the appropriate fiscal year of the report and the page number cited).

"...nobody at the political level from 1961 to 1971 had put the energy behind developing the doctrine and the plans. Many statements can be found saying that flexibility or selectivity would be desirable. But before this time it had been sort of an aspiration."[1]

The issue of strategic nuclear flexibility also continued to be a topic of study and debate in the lower echelons of the defense community. The RAND Corporation, for example, participated with the Air Force in an examination of alternative nuclear options in the mid-1960s. Responsibility for the project at RAND fell under the purview of its director of strategic studies, who at the time was Dr.James R.Schlesinger.[2]

Immediately after President Nixon was inaugurated in January 1969, the National Security Council staff, initiated several studies concerning U.S. strategic forces and strategic doctrine. The first of these studies resulted in National Security Study Memorandum (NSSM) 3, which addressed the issue of strategic "sufficiency" - that is, the size requirements of the U.S. strategic forces given their purpose and the expected Soviet threat.[3] A later study that same year addressed the efficacy of the assured destruction concept's emphasis on the destruction of Soviet cities and population given the relatively new situation of near parity in the strategic capabilities of the U.S. and the Soviet Union. According to defense columnist Michael Getler, the development of alternatives to the assured destruction doctrine was a "top-priority" item within the NSC.[4]

---

1 U.S.Congress, <u>op.cit.</u>, p 26.

2 Interview No. 17.

3 John Newhouse, <u>Cold Dawn: The Story of SALT</u>,(New York: Holt, Rinehart and Winston, 1973), p 149

4 Michael Getler, "On the Other Hand, Mr. President," (<u>Armed Forces Management</u>, April 1970), p 23.

President Nixon also made a number of references to the issue of strategic flexibility. For example, in his first State of the World Address in 1970, he rhetorically asked,

> "...Should a President, in the event of a nuclear attack, be left with the single option of ordering the mass destruction of enemy civilians, in the face of the certainty that it would be followed by the mass slaughter of Americans? Should the concept of assured destruction be narrowly defined and should it be the only measure of our ability to deter the variety of threats we may face?"[1]

At a later point, Nixon specifically related the issue of strategic flexibility to the question of command and control:

> "We have reviewed our concepts for responses to various possible contingincies..We must insure that we have the forces and procedures that provide us with alternatives appropriate to the nature and level of the provocation. This means having the plans and command and control capabilities necessary to enable us to select and carry out the appropriate response without necessarily having to resort to massive destruction."[2]

In August 1972, William Beecher of the New York Times reported that the Nixon administration was "...quietly moving to shift the emphasis of American strategic planning in case of a major war and to develop bigger, more accurate warheads... to carry-out such plans."[3] According to the same report,

---

1 Quoted in, Department of Defense, op.cit. p 35.

2 U.S.Congress, House of Representatives, Committee on Foreign Affairs, Message from the President of the United States Transmitting His Second Annual Review of Foreign Policy, February 25, 1971, p 133.

3 New York Times, August 5 1972, p.6.

President Nixon's special advisor on national security, Henry Kissinger, was to chair a special interagency group responsible for developing additional nuclear war options.

The "Schlesinger Strategy"

The issue of increased nuclear options did not officially re-surface until January 10, 1974, when Secretary of Defense James Schlesinger announced in a news conference that "...there had taken place a change in the strategies of the U.S. in regard to the hypothetical employment of central strategic forces."[1] Accordingly, the Pentagon had formulated "...targetting options which are more selective and do not involve major mass destruction on the other side."[2]

In the annual Defense Department report for fiscal year 1975, Schlesinger further explained that the doctrine of massive retaliation had dominated the rhetoric of U.S. strategic doctrine since World War Two.[3] Assured destruction was essentially a manifestation of this earlier doctrine. Schlesinger argued that the assured destruction concept provided its proponents with a useful device for calculating the optimum size of U.S. strategic forces. However, in the event of an actual war, it severely restricted the number of strategic options which the President could exercise. In much the same way that selective response had been justified in the early McNamara years, the report went

---

1 Quoted in Herbert Scoville, "Flexible Madness?" (Foreign Policy, Spring 1974), p 164.

2 Quoted in Michael T.Klare, "Making Nuclear War 'Thinkable'," (The Nation, April 13, 1974), p 461.

3 Department of Defense, op.cit., p33.

on to argue that deterrence could fail as a result of accidents, unauthorized acts, irrational calculation, and escalation from limited conflict. Schlesinger thus concluded,

> "...To the extent that we have more selective response options - smaller and more precisely focused than in the past - we should be able to deter such challenges. But if deterrence fails, we may be able to bring all but the largest nuclear conflicts to a rapid conclusion before cities are struck. Damage may thus be limited and further escalation avoided... Which among these options we choose would depend upon the nature of the enemy's attack and his objectives."[1]

Schlesinger acknowledged that several strategic nuclear response options had in fact been added to the U.S. contingency war plans in 1961 and that the necessary retargetting of strategic nuclear forces had been completed to provide for the implementation of these options. These options reportedly included "...military only and military plus urban industrial (attack) variations."[2] Schlesinger was, however, not satisfied with the degree of flexibility which even these changes afforded. In later testimony before a Senate subcommittee he indicated,

> "...In the past we have had massive preplanned strikes in which one would literally be dumping thousands of weapons on the Soviet Union. Some of these strikes could to some extent be withheld from going directly against cities, but that was limited even then...It was virtually indistinguishable from an attack on cities."[3]

---

1 ibid., pp 38-9.

2 ibid., pp 36 and 33.

3 U.S.Congress, Senate, op.cit. p 9.

The purpose of the change in targetting then was to provide even more limited and discriminatory options than provided by the changes effected in the McNamara period, some twelve years before. Schlesinger described the change as giving the President of the United States the option of "limiting strikes down to a few weapons."[1]

In the final analysis, the strategic nuclear doctrines outlined by McNamara and Schlesinger are in fact remarkably similar. Both were based on the assumption that deterrence of attacks against the U.S. itself or its allies, however constructed, might fail. In the event of a nuclear war between the United States and the Soviet Union, both argued that the U.S. decision-makers should not be limited to launching massive strikes against the Soviet Union. They should, instead, have at their disposal a variety of strategic nuclear options which they could exercise, depending upon the nature and character of the situation. The similarity between the so-called McNamara and Schlesinger strategies diverges, however, in the sense that the options which were incorporated in the SIOP during the McNamara years apparently included only relatively large-scale attacks. Schlesinger, on the other hand, has indicated a need to include more limited and discriminating attack options within the context of the SIOP. In short, the fundamental trend in the development of official U.S. strategic nuclear doctrine since 1961 can be characterized by increasing emphasis on the degree of flexibility with which the strategic forces could be used in the event of a nuclear war.

---

1 ibid.

As Secretary Schlesinger's remarks quoted in the Introduction have suggested, the degree of flexibility with which strategic nuclear forces can be used depends to a considerable extent on the capabilities of the strategic command and control systems. Having discussed the more salient features of the U.S. strategic nuclear doctrine, the next task then is to examine the actual relationship of command and control to the implementation of particular doctrines.

CHAPTER TWO

Command and Control and Nuclear Strategy

Definition and History

Despite the fact that the term "command and control" has achieved widespread circulation only since the Second World War, the functions implied by it are by no means unique to the nuclear age. The dual process of commanding and controlling military forces is at least as old as organized warfare itself. However, like so much of the vocabulary of contemporary strategic issues, the term command and control has been subject to a variety of uses and interpretations. The confusion regarding its precise definition no doubt results primarily from the very complexity of the command and control of strategic nuclear forces and the various and often conflicting ways in which this problem has been perceived by military planners, technologists, and defense strategists.

For the purposes of this study, command will be defined as the process of military decision-making. This definition is by no means unique, having been used by military officers, as well as technologists.[1] As with more general forms of the decision-making process, command can be viewed as comprising three principle phases: determining the need to make a decision, finding possible courses of action, and choosing among alternative

1 For example, Maj. Gen. C.H.Terhune, "Commander of ESD Answers Questions for DATA Readers", (Data, March 1963), p 10.

courses of action.[1] In order to develop and choose among alternatives, however, the decision-maker, or in this case the military commander, obviously requires certain kinds of information regarding the situation in which he must act. This information might include such items as the size and disposition of opposing forces, the relative strengths and weaknesses of the enemy, developments in the course of a battle, etc. Consequently, the means by which such information is collected, transmitted and presented to the decision-maker has generally been closely associated with the command process itself. A number of contemporary command and control specialists have even described the existing systems designed to provide for command and control of the strategic forces as "military information systems".[2] This emphasis on the informational aspects of the command process serves to illustrate their importance, but at the same time tends to obscure the basic property of command - namely, decision-making.

Control, on the other hand, has been defined as the means by which the decisions of the commander are issued to the forces selected to implement them.[3] It follows that the question of control is rather closely related to the ability of the commander to communicate with his forces. Since communications is not defined as a functional aspect of the command and control process,

---

1 Lt. Col. Clifton L.Nicholson, "Command and Control and the Decision-Making Process, (Air University Review,November-December, 1963), p 78.

2 For example, Maj. Gen. John W.O'Neill, "From the Commander," (Signal, April 1966), p 14.

3 "The Search for Effective Command and Control", (Armed Forces Management, July 1962) p 19.

it has generally been discussed separately. However, more recently, the term "command and control" has given way to the term "command control communications" in the parlance of military planners, indicating a closer identification of all three areas of concern.

Prior to the First World War, both the command and the control of military forces could in most cases be exercised under the direct and immediate supervision of the commander. For the most part, the pre-Twentieth Century battlefield could be measured in acres which the commander could readily survey from the proverbial "high-ground". Napoleon, for example, reportedly "...always positioned himself well forward during battle action, insuring personal observation over the most critical areas...so that he could judge for himself how the battle was going."[1] Major decisions were often made just prior to or even during the course of the battle and often without resort to elaborate planning and preparation. Napoleon, again, was reported to have acted as his own G-3 (operations planning staff), often "carrying his strategy in his head."[2] Forces were controlled with the use of binoculars, bugles, runners and signal flags. While one's own forces might respond slowly to commands, the enemy could not be expected to move much faster. As one Air Force command and control specialist wrote in 1960, "In a simpler world, the commander had simpler problems."[3]

---

1 Col. Wesley W.Yale, "Command and Control in the Grande Armee", (Armor, September-October, 1969), p 3.

2 ibid.

3 Maj. Gen. Kenneth P.Bergquist, "Aerospace Command and Control", (Air University Quarterly Review, Winter-Spring, 1960-1961), p 195.

Even before the Twentieth century, the history of command and control capabilities was by no means static. Instead, the means by which both functions were accomplished evolved over a period of time, primarily in response to the opportunities afforded by technological innovations. For example, during the siege of Paris in 1870 to 1871, observation of military operations was supplemented by the use of lighter-than-air balloons. During the American Civil War, the telegraph extended the distance and speed with which strategic information could be transmitted, allowing in part the control of actual military operations from distances as far from the battlefield as the White House.[1]

The Second World War, however, witnessed perhaps the most dramatic steps in the evolution of command and control techniques prior to the nuclear age. The advances of this period were predicated on two comparatively recent technological innovations, namely, radio communications and radar. The capabilities afforded by these two developments were in a sense necessitated by the use of new weapon systems - particularly the tank and aircraft - whose respective ranges out-stripped the ability of the commander to directly control their use. The British, for example, were particularly successful in their employment of the combined use of radio and radar to direct the operations of a relatively limited number of fighter aircraft during the Battle of Britain. Based on information obtained from the

---

1 Bernard and Fawn Brodie, From Crossbow to H-Bomb, (Bloomington: Indiana University Press, 1973), p 130.

British coastal radars, Fighter Command was able to make almost immediate decisions regarding the most efficient course of action regarding the use of its resources and to subsequently instantaneously relay its decisions to fighter units dispersed throughout Britain.[1] A recent U.S. Army War College study has concluded that the British air defense command and control system was the major factor in the 1940 British victory over the German Luftwaffe which had begun the battle with a 3 to 1 margin of superiority.[2]

The Impact of Nuclear Weapons Technology.

The development of nuclear weapons and their associated delivery systems, has served to render the more traditional means of command and control largely irrelevant to the conduct of military operations, at least as far as strategic nuclear forces are concerned. The range of intercontinental bombers and missiles implies an extension of the strategic theatre of operations well beyond the limits of the traditional battlefield. The dispersal of the strategic forces, as well as their intended targets, over vast geographical areas makes direct supervision by a single commander virtually impossible. The speed of missiles would considerably compress the time frame in which decisions would need to be made and orders issued in the event of an

---

1 Lt. Col. Frank E. Owens, et al., Command and Control Systems Evolution and Management in DOD, (U.S. Army War College, Carlilse Barracks, Pa., May 1974), pp 2-3.

2 ibid., p 3.

actual war. Furthermore, the destructive power of nuclear weapons and the concommitant political implications of their use have led U.S. policy makers to conclude that a very strict and centralized control of their use is both tactically and politically necessary. In 1960, an Air Force general responsible for Air Force command and control developments described the changing character of strategic weapons systems as having created a "crisis in command". He further commented that, "The extreme quantity and abstract quality of data, the compression of decision time, and the necessity for rigid control to avoid accidents, have imposed this crisis on operational commanders."[1]

While the Air Force and other Defense Department officials were concerned about the problems which nuclear weapons technology had posed for the command and control of strategic forces, most of them apparently had no doubts about the manner in which the problem could be solved. The same Air Force officer who had described the "crisis in command" at another point commented that:

> "Fortunately we can turn to technology for the answers to the very problems it has created. Concurrent with, and partially as a result of, the breakthroughs in warhead and delivery systems performance came data processing machines (computers) that can process, store, and present vast masses of data at micro-second speeds. The notion was conceived that perhaps such machines, coupled with electronic information gathering devices and electronic communications techniques, might put the reins of command back into the hands of the commander."[2]

---

1 Maj.Gen.Kenneth P.Bergquist, "'Crisis in Command'", (Air Force and Space Digest, December 1960), p 105.

2 Bergquist, "Aerospace Command and Control", op.cit., p 197.

The search for the solution of the command and control problems inherent in the operations of nuclear strategic forces in terms of modern electronic technology has in fact been the dominant characteristic of command and control developments since the Second World War. As will be detailed in the following chapters, it has resulted in the construction of extensive and elaborate systems designed to provide the military decision-maker instantly with the information and the mathematical calculations required to make decisions regarding the employment of the strategic forces, as well as the means to transmit those decisions to the forces.[1] The official Defense Department definition of command and control in effect reflects the systemic aspect of command and control in the nuclear age, by defining it as

---

1 The enthusiasm and optimism regarding the possibilities afforded by the latest electronic technology in solving the problems of command and control associated with nuclear strategic forces was not universally shared by members of the scientific and defense communities. For example, Dr. Herbert York, a former member of the President's Scientific Advisory Committee and former Director of Defense Research and Engineering has written, that "...the overall complexity of systems is leading us to a situation in which the response to a future attack will be so complicated and the time in which to decide what to do will be so short that it will be necessary to turn to automatic computing machines for the purpose. If we continue with the present style of technological approach to defense problems, the inclusion of human beings in the decision-making loop will seriously degrade the performance of the system. Thus, here too the power to make life-and-death decisions is passing from the hands of statesmen and politicians to lower level officers and ultimately to computing machines and the technicians who program them. This trend, if allowed to continue will result in the capture of public policy by a scientific-technological elite." Herbert York, Race to Oblivion: A Participant's View of the Arms Race, (New York: Simon and Schuster, 1970), pp 13-14.

"...the exercise of authority and direction by duly designated authorities...through an arrangement of personnel, equipment, communications, facilities and procedures which are employed in planning, directing, coordinating and controlling operational activities of U.S. Military Forces."

If the Air Force and professional strategists were confident that electronic technology could solve the problems associated with the command and control of strategic forces, they were at the same time concerned that the kinds of systems that would be built would directly affect the manner in which those forces could be employed. In one of the more significant unclassified studies published on command and control in the early 1960s, Thornton Read coutioned that,

> "One of the most important long-term requirements on command and control is that they should *restrict short term* choices as little as possible. Strategies should not inadvertently be built into the command and control system."[2]

This relationship between command and control systems and strategy results from the information and control capabilities which are required to implement a particular strategy. These requirements in fact differ considerably for a massive retaliation strategy and the more flexible selective response strategy. The extent to which the command and control system can meet the actual operational requirements implied by particular

---

1 U.S.Department of Defense, "Worldwide Command and Control System (WWMCCS)," Department of Defense Directive 5100.30 December 2, 1971, p. 2.

2 Thornton Read, Command and Control, (Policy Memorandum No. 24, Center of International Studies, Princeton University, June 15, 1961), p. 21.

strategic doctrine in effect determines the extent to which that doctrine could be implemented in the event of a real war.

Command and Control Requirements for Massive Retaliation

As was discussed in the previous chapter, the U.S. policy-makers of the 1950s had defined U.S. strategic nuclear doctrine in such a way as to imply that the U.S. response to a Soviet attack against the Western European allies or against the U.S. itself would result in an automatic, massive counterattack. One leading command and control specialist, Herbert Benington, succintly described this kind of "spasm response" as a strategy in which,

> "...political considerations no longer affect the conduct of war after enemy actions have crossed some threshold - beyond which point strategic offensive forces would be delivered as quickly and effectively as possible to inflict maximum damage on the enemy."[1]

It follows that the information which would be required by the relevant decision-makers before they would decide to launch such a spasm response would concern whether or not the enemy had in fact crossed the "threshold". Even within the context of a spasm response strategy, several scenarios can be constructed which suggest that somewhat more complex information than the mere existence of an attack might be necessary. For example, the threshold of unacceptable provocation might be set higher

---

1 Herbert Benington, "Command and Control for a Selective Response", in Klaus Knorr and Thornton Read, Limited Strategic War, (London: Pall Mall Press, 1962), p 124.

than, say, one attacking missile, in which case the command and control system would need to provide some idea of the size of the attacking force.

In terms of control of the strategic forces, a spasm response doctrine further suggests that once the decision had been made to proceed with an attack, the strategic forces would be ordered <u>en masse</u> to attack those targets which they had been pre-assigned by the pre-war contingency plans. The actual control system which would be required to implement such a strategy would thus not need to be any more complicated than one which could transmit a single message of "go-code" which would order the forces to launch an attack against those targets. Command and control specialists have consistently held that the command and control system necessary to support a massive retaliation, or spasm response strategy "...must possess absolutely unequivocable warning systems and less survivable, but very rapid execution communications."[1] In other words, the functions which a command and control system would need to be capable of performing in order to implement a spasm response strategy would be essentially two-fold: namely, 1. Warning of an attack (usually referred to as tactical warning), and 2. Some means of getting out the "go-code".

Command and Control Requirement for a Selective Response

The information and control requirements necessary to

---

1 Maj.Gen. Lee M.Paschall, "C^3 and the National Strategy", (Signal, April 1974), p 8.

implement a selective response strategy have, on the other hand, been defined by Air Force and professional strategists in such a way that they can be considered to be qualitatively different from and at the same time more complex that those required for a massive retaliation strategy. As discussed in the previous chapter, the selective response doctrine suggests that in the event of a nuclear war, the U.S. decision-makers would not be limited to launching an all-out attack, but instead would select specific strategic options based on the nature and character of the enemy attack. Translated into informational requirements, this implies that the relevant U.S. decision-makers would in fact need to know the actual nature and character of the enemy attack in order to select the proper option for the situation. Following this logic, command and control specialists, like Benington writing in 1962, have been led to conclude that for a selective response strategy the command and control system would need to provide for "...warning, reconnaissance, and damage assessment that allows some deliberate classification of the situation before, during and after the enemy attacks."[1] Writing some 12 years later, Air Force Maj. Gen. Lee M.Paschall, then Director Command Control and Communications for the Air Force, described the command and control system necessary for implementing a selective response strategy as consisting of "...highly reliable warning systems, including some level of attack assessment capability, rather extensive communications containing almost invulnerable hard-core execute and report back

---

1 Benington, op.cit., p 127

capability, and considerable data-processing capability."[1]

The functions which have been defined as necessary can be summarized as: tactical warning, attack assessment, damage assessment, and an extensive control of the strategic forces, including what one Air Force manual has described as "reconstitution and redirection of the strategic forces."[2]

A comparison of the command and control functions which have been defined as being necessary for the implementation of either the spasm response or the selective response doctrines reveal that tactical warning is the only common element in both sets of requirements. The other functions are essentially unique to the selective response strategy, and should perhaps be described in greater detail.

Attack assessment has been officially defined in a study conducted by the Air Force in the early 1970s as an evaluation of information from satellites and missile surveillance systems (which will be examined in the next chapter) to determine the nature and character of the enemy attack.[3] The Air Force definition also details what exactly is implied by "nature and character of the enemy attack", including:

---

1 Paschall, op.cit., p 8.

2 U.S.Department of Defense, "WWMCCS - World-wide Military Command and Control System", (Commanders Digest, February 14, 1974), p 5.

3 Col. Douglas W.Carmichael, "Attack Assesment", Space and Missile Organization (USAF/AFSC), Los Angeles, California, December 14, 1973, (Unpublished paper), p 3.

"...(1) Attack origin - the source of the attack; (2) Attack Timing - the time of nuclear bursts, predicted impacts and re-entries; (3) Attack Size - number of weapons; (4) Weapon and Payload Identification - weapon types and penetration aids; and, (5) Attack pattern - type and distribution of targets under attack. Attack pattern could include, in order of increasing precision, the country under attack, the general area under the attack (portion of the country), classes of targets under attack (retaliatory forces, cities (urban/industrial areas), or mix), the target complex (missile farm) or large target (city) involved, or the exact installation (silo, airfield, command center) targetted."[1]

The definition of attack assessment furnished by the Air Force appears to be in fact a "working definition" for a current Air Force programme which is studying the means of refining current attack assessment capabilities (discussed in the next chapter), and not all command and control specialists would necessarily agree that all the elements contained in the above definition would be the kinds of attack assessment information which would be needed to select options in the implementation of a selective response strategy.[2] However, the Air Force definition of attack assessment is perhaps the most comprehensive that has been offered, and the extent to which it can be realized is a matter for the next chapter to explore.

---

1 ibid.

2 For example, Maj. Gen. Lee M. Paschall, current Director of the Defense Communications Agency has written: "...There are some tough questions that remain to be answered. Most of them are of the how much variety...such as: How much attack assesment is required?" Maj. Gen. Lee M.Paschall, Command and Control: Why the Air Force's New Systems Are Revolutionary", (Air Force Magazine, July 1974), p 61-2.

Damage assessment generally refers to an evaluation of the actual physical effects caused by an attack. Damage assessment can refer either to the damage which has been sustained by the U.S. as the result of an enemy attack, or to the damage inflicted by the U.S. on the enemy.[1] The former kind of damage assessment serves much the same function as attack assessment in that it would allow U.S. decision-makers to gain some appreciation of the nature of the enemy attack. If, for example, damage assessment reports indicated that an enemy missile attack on the U.S. had only resulted in nuclear detonations on a single Minuteman missile base, the U.S. leadership might be able to conclude that the enemy had not intended to launch a massive counter-value attack. This type of damage assessment would also be useful in determining how many forces had survived the initial enemy attack and were available for use in the U.S. response.

Assessment of the damage inflicted by the U.S. attack on the enemy (often called "strike assessment") has been associated with at least two purposes. First, information concerning which enemy targets had been successfully destroyed would allow the relevant decision-makers to cancel any subsequent attacks against those targets, or to order additional strikes against those targets which were reportedly not destroyed in the first attacks. Second, information regarding the effectiveness of the U.S. attacks against the enemy would be important items in any interwar or immediate postwar negotiations with the enemy.[2]

---

1 Interview No 6.

2 "Interwar negotiation" is discussed in Kahn, op.cit., Kissinger, op.cit., and Knorr and Read, op.cit.

In addition to a more detailed picture of the course of the battle suggested by the attack and damage assessment functions, the selective response strategy has been described by some Air Force and Defense Department officials as requiring a more extensive and more sophisticated ability to control the operations of the strategic forces than is implied by a more simple "go-code" capability. Command and control specialists have long contended that the more options any military force may be expected to exercise, the more complex the control systems that direct the force must be.[1] As noted above, the implementation of a spasm response strategy requires only that the strategic nuclear forces receive "one message, one time". More selective options would require that specific forces be directed to launch attacks against particular targets. The control system that would be required to formulate and to then transmit these directions would obviously need to be somewhat more sophisticated than a system which would only be required to transmit a single message.

Summary

The purpose of this chapter has been to identify the salient aspects of the command and control process, as well as to differentiate between the functions which particular strategic doctrines require of a command and control system for their

---

1 For example, "Can Vulnerability Menace Command and Control?" (Armed Forces Management, July 1969).

implementation. The particular command and control functions which command and control specialists have associated with a massive retaliation or spasm response strategy have been shown to be qualitatively different from those necessitated by a selective response doctrine.

Thus far, this study has been confined to a discussion of command and control in the abstract. Command and control capabilities and functions are, however, the product of the operation of actual systems. The following chapters will focus on the design and development of strategic command and control systems in the U.S. as well as examining the relationship of their respective technical capabilities to the implementation of particular strategic doctrines.

CHAPTER THREE

Tactical Warning Systems and Attack Assessment

Setting the Stage: The Precedent of SAGE

Establishing the starting point for any particular historical process involves in many respects a highly arbitrary decision. Rarely can history be described strictly in terms of discreet, sharply delineated events. Rather, each new development depends to a considerable extent upon those which preceded it. With this one caveat concerning the cumulative nature of history firmly in mind, the first stages in the development of the present U.S. strategic command and control systems can, for the purposes of this study, be traced to 1949. Prior to this year, the principle military threat to the U.S. interests had been perceived by U.S. policy-makers in terms of a Soviet attack upon Western Europe. However in 1949, the Soviets broke the U.S. monopoly on atomic weapons and U.S. defense planners for the first time began to seriously consider the prospects of a direct attack of major destructive proportions upon the U.S. homeland itself.

Correspondingly, increased attention was focused by both military and civilian defense analysts on the problem of U.S. air defense against bomber attack, which at the time was the only means by which Soviet atomic weapons could have been

delivered to the U.S. targets.[1] In 1949, the Air Forces's Scientific Advisory Board established an Air Defense Systems Engineering Committee to study the problem of coordinating the air defense of the contintental land mass that was the United States with a correspondingly far flung defensive force. The committee was headed by Dr. George Valley of the Massachusetts Institute of Technology. Significantly, MIT's engineering expertise would be very much involved with Air Force command and control developments for the next two decades. The following year, the committee concluded that the Air Force should design and develop a combination of radars, communications, and computers to facilitate the direction of an air defense.[2] The Air Force subsequently requested MIT to fully develop this computer-aided air defense concept, a task which MIT delegated to its newly created Lincoln Laboratory. Early in 1951, the Lincoln Laboratory outlined an air defense system, "...using high speed computers to receive, process, and transmit air surveillance, identification, and weapons guidance information."[3] In May 1953, the Air Force formally accepted the Lincoln Laboratory proposal as the basis of the U.S. air defense system and that same year it initiated the development of the Semi-Automatic Ground Environment (SAGE) System to implement this concept.

The SAGE system was in many respects the logical extension of the kind of radar defense employed by the British in the

---

1 An excellent, detailed analysis of the impact of Soviet nuclear weapons development on U.S. strategic calculations, particularly in regard to air defense, is found in George H. Quester, Nuclear Diplomacy: The First Twenty-Five Years, (2nd ed.) (New York: Dunellen, 1973), pp. 73-82.

2 "Command and Control History", (Signal, April 1966), p. 55.

3 ibid.

the Battle of Britain. SAGE, which was subsequently dubbed 416L by the Air Force,[1] ultimately consisted of a series of radar sites, including the DEW Line radar system situated in Northern Canada, which were linked to regional control centres. Computers installed at the regional control centres were designed to process and present the information obtained from these radars in order to aid human controllers with the complex computational task of directing the interception of approaching bombers with fighter aircraft and air defense missiles. Actual decision-making authority was to be retained by the human commander, hence the term "semi".

Development and refinement of the SAGE air defense concept and system continued throughout the 1950s; however, by the early 1960s, the entire system was being phased-out. The SAGE system had been constructed before a missile attack was considered to constitute a real strategic threat and before the development of high-yield nuclear warheads. Once the Soviet versions of these systems became operational, the SAGE system in effect became highly vulnerable to even indirect attack. While several measures were taken to protect the SAGE control centres against certain residual nuclear weapons effects - such as radioactive "fallout" - the Air Force had decided by 1962 that the steps which would be necessary to harden the SAGE sites could not be justified because of the costs that would be involved in such an effort.[2]

---

1 An "L" system is defined by the Air Force as "a composite of equipment, skills and techniques capable of supporting an operational role." Air Force Policy Letter for Commanders (Supplement), August 1964, No. 9.

2 Department of Defense, Annual Report, FY 1963, p 16.

Correspondingly, increased emphasis was accorded by the Air Force to its so-called Back-up Interceptor Control (BUIC) System (416M) which had originally been designed to take over the direction of air defense should any of the SAGE control centres become inoperative of disabled.[1] In justifying the shift from the SAGE to the BUIC system, McNamara stated in his 1965 annual report that, "Although it cannot handle as many targets or interceptors as SAGE centres, the BUIC system is less vulnerable, less costly to operate, and more commensurate with today's manned bomber threat."[2]

Aside from any questions concerning the survivability or cost of the SAGE system, by the mid-1960s the very raison d'etre of anti-bomber defense in any form was losing its former validity, at least in the opinion of McNamara and many of his staff. By then the major strategic threat to the U.S. was defined in terms of the Soviet land-based missile systems and any interest in active defense was correspondingly shifted to questions of anti-missile defense. Furthermore, throughout the latter half of the 1960s the Soviets appeared to be making no efforts to improve their inter-continental bomber capabilities, which consisted of aging *Bison* and *Bear* deployed in far fewer numbers than the U.S. B-52 bombers.[3]

---

1 'Surveillance and Control Systems", (*Signal*, April 1966), p. 23.

2 Department of Defense, *Annual Report, FY 1965*, p 17.

3 Specifically, the Soviet deployment of long-range bombers reached its peak in 1967 with about 210 *Bison* and *Bear*. That force steadily declined to a total of 140 operational aircraft in 1971 and since that time no increases have been made. The Soviet *Backfire* bomber, presently considered a medium-range bomber, would reportedly be capable of inter-continental ranges if the Soviets were to develop a more extensive in-flight refuelling capability than they have at present. International Institute for Strategic Studies, *The Military Balance, 1974-75*, (London, 1974) p 75.

Perhaps even more significant than the size of the Soviet bomber force as far as the issue of anti-bomber defense is concerned was the 1972 agreement between the United States and the Soviet Union to restrict the deployment of anti-missile defense systems. In early 1974, Secretary Schlesinger was led to conclude in his annual report that,"... since we cannot defend our cities against strategic missiles, there is nothing to be gained by trying to defend them against a relatively small force of Soviet bombers."[1] His report further indicated, not surprisingly, that plans had been formalized to phase-out the last operational BUIC control centres in the U.S.[2]

In keeping with the new "primary mission" of the U.S. air defense forces, which Schlesinger later defined in the FY 1976 annual report as insuring the sovereignty of U.S. air space <u>in peacetime</u>, the command and control functions which had once been delegated to the SAGE and BUIC systems were to be performed from 13 control centres to be used jointly by the Air Force and the Federal Aviation Agency (FAA). Recent study of this proposal has led the Pentagon to conclude that the joint use of the same facilities for routine air traffic control by the FAA and the air defense operations of the Air Force would be "inefficient in peacetime and unworkable under actual combat conditions." Thus, plans have been formulated to establish four Regional Operations Control Centers (ROCCs), which would process information from some 43 military/FAA joint use surveillance radars, for the command and control of air defense operations in the continental

---

1 Department of Defense, <u>Annual Report, FY 1975</u>, p 67.

2 ibid., p 69.

United States.[1]

Whatever its eventual fate, the SAGE system was an important episode in the history of the development of the U.S. strategic command and and control system. The SAGE system represented the first large scale effort on the part of the Air Force to develop a command and control system which was designed to gather information with remote electronic sensors and to employ computers to process and present that information in such a way as to facilitate the decision-making process of the human commander and to aid his direction of the operations of military forces. As such, the SAGE development programme and concept set the pattern for subsequent command and control systems. One Air Force general summarized the contribution of SAGE to later projects as "... a great laboratory which has provided an outpouring of ideas for exploitation of technology in defense ... For indeed SAGE has been the proving ground which has launched us into the field of automated command and control."[2]

---

1 Department of Defense, Annual Report, FY 1976, pp 11-41-3.

2 Maj. Gen. John B.Bestic, "The National Military Command System", (Signal, September 1963), p.17. Not everyone has derived such optimistic lessons from the experience of the SAGE development programme. For example, J.C.R.Licklider (of M.I.T.) has commented that the design and development of SAGE, as well as several other command and control systems have demonstrated that the sheer complexity of the problems of computer programming ("software") and of "man-machine interface" associated with these systems have been consistently underestimated by engineers and military planners. This has in turn led to serious underestimations of the times and costs required to complete a programme, as well as an exaggeration of the actual capabilities which can be expected of a particular system. J.C.R. Licklider, "Underestimates and Overexpectations" in Abram Chayes and Jerome B.Wiesner, ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System, (New York: The New American Library, Inc., 1969), pp.118-129.

Furthermore, for its time, SAGE and the entire complex of U.S. radars located both in the U.S. and Canada seem to have been well suited to perform the function of early warning of a strategic attack. The so-called 1957 Gaither Committee, which reported on the status of American active and passive defense measures, appears to have been fairly well satisfied with then current U.S. capabilities to provide timely warning of a surprise bomber attack, suggesting only that the radars which faced the seas be modernized and extended to prevent "end runs".[1] However, as was recounted above, by the mid-1950s U.S. defense planners had concluded that in the near future the U.S. would be confronted with an entirely new strategic threat, in the form of Soviet ICBMs. The Gaither Committee report clearly reflected this growing concern with Soviet missile development and made specific proposals to President Eisenhower regarding a U.S. response to the new situation. In the area of tactical warning, it recommended that the U.S. develop to an operational capability a radar early warning system to detect an ICBM attack launched from the Soviet Union.[2] The committee justified such a system in terms of preserving the credibility of the U.S. nuclear deterrent by lessening the vulnerability of the SAC bomber force to surprise missile attack. Early warning combined with quick reaction alert capability (also recommended by the

---

1 Security Resources Panel of the Scientific Advisory Committee, "Deterrence and Survival in the Nuclear Age (NSC 5724)", November 7, 1957, para III.A.1.b.

2 *ibid.*, para. III.A.2.

report) would supposedly allow the SAC bomber force to be airborne before they could be destroyed by incoming ICBM warheads. The report further suggested that such a missile early warning capability was technically feasible, but cautioned against a crash programme to fully develop it.[1]

The Ballistic Missile Early Warning System

If in fact an early warning system to warn against an ICBM attack was technically feasible in 1957, it had only just recently become so. The tentative plans for such a system had been based on the concept of extending existing radar technical capabilities. Since radar could detect aircraft in flight at a considerable distance, the logic must have run, then the same principle could be applied to detect missiles in flight. However, given the speed at which missiles could travel and arrive at their targets, warning of their approach would need to be provided as soon as possible after their launch if it was to be at all useful in its stated purpose of protecting the SAC forces against surprise attack. This strategic consideration implied a technological requirement for a long-range radar system capable of detecting objects the size of missiles at ranges of several thousands of miles, which clearly did not exist during World War II or the years immediately following it.[2] Significantly, in 1957, the Air Force had embarked on the development

---

1 _ibid_., Appendix F, para. B.1.

2 The technical problems and limitations associated with radar in the decade following the Second World War are discussed by one of its inventors in Sir Robert Watson-Watt, "Radar Defense Today - and Tomorrow," (_Foreign Affairs_, January 1954).

of a high powered transmitting tube that would reportedly extend the state of the art by a factor of 100, as well as sponsoring research on a large "toros-type" antenna.[1] The research and development of the very technology which was necessary for an ICBM warning system had thus preceded the initiation of a formal programme to develop such a capability - however, not by much.

In 1958, the development of a Ballistic Missile Early Warning System (BMEWS) was actually started. As with the SAGE system, the Air Force was again the service with responsibility for the new project, which it designated 474L. BMEWS ultimately comprised three radar sites; at Clear, Alaska; Thule, Greenland; and Fylingdale Moors, England. The system became fully operational in January 1964 with the completion of the England site, although the system had been functioning at a lower level of intensity prior to that time.[2] Radio Corporation of America had been designated as the prime contractor for the entire system, although the completion and refinement of the system reportedly involved some 2900 U.S. companies - most notably General Electric which built the "football field" size detection radars, and the Western Electric Company, which the Air Force separately contracted to construct the communications network which tied all three sites to the North American Air Defense Command (NORAD) Headquarters in Colorado.[3]

---

1 Dr. John S.Burgess, "The Research Frontier: Planning the Design and Development of Electronic Components", (Air University Quarterly Review, Summer 1962), p 113.

2 Department of Defense, Annual Report, FY 1965, p 12.

3 Signal, April 1966, pp 22-3.

Even with the completion of BMEWS in 1964, Pentagon officials were concerned that it would not afford sufficient warning time of a ICBM attack to allow the SAC bomber force to become airborne before their bases were destroyed. Air Force officials reported that the BMEWS was capable of providing only about 15 minutes warning of a mass missile attack launched over the northern polar routes from the Soviet Union to the U.S. and southern Canada.[1] The limitation of the BMEWS warning time to 15 minutes was essentially geophysical in nature. The large transmitters of the BMEWS detection radars only propagate radio waves in a straight line - in other words, along the "line of sight". Consequently, the BMEWS radar signals are not normally able to bend along the natural curvature of the earth. Thus, missiles launched from the Eurasian land mass would not be detected by the BMEWS radars until they had in effect "cut" the outbound radio signals. Apparently, this would not happen until some 10 or 15 minutes after they had been launched - that is, 15 minutes before their warheads could arrive at their targets. The Air Force was not convinced that 15 minutes was enough time to launch the SAC bomber force, or to take the necessary precautions to protect the national decision-makers and implement any civil defense measures. The Air Force thus argued the need to develop systems that would increase the warning time in the event of an attack. Significantly, in 1961, even before the BMEWS was completed, McNamara announced in his annual report that

---

1 Col. N.J.McGowan, "Deputy for System Management Outlines Functions", (<u>Data</u>, March 1963), p 30. The BMEWS is also designed to warn of an intermediate-range missile attack against the United Kingdom.

efforts were underway to develop other systems which would serve to increase tactical warning time in the event of an attack upon the United States.[1]

The Early Warning Satellite System

The first of the Air Force efforts to improve the U.S. early warning capabilities was the development of an early warning satellite which would be capable of detecting ICBMs immediately after they had been launched from a vantage point in space. As with virtually every command and control system, the early warning satellite represented an attempt to apply the most recent technological innovations to perform command and control functions. In 1959, the Air Force started development of a Missile Defense Alarm System (MIDAS), apparently as part of the Lockheed WS -117L project that also included development of the early reconnaissance satellites.[2] The basic principle behind the MIDAS concept was the detection of missile launches with the use of sensitive infra-red sensors which could detect the hot exhaust "plumes" emitted by a missile in flight.

At first, the Air Force had apparently envisioned a more extensive role for the MIDAS than simply the detection of missile launches. In 1960, the Secretary of the Air Force reported on Air Force proposals for an active anti-missile defense system in the annual Defense Department report,

---

1 Department of Defense, Annual Report, FY 1962, p 10.

2 Ted Greenwood, Reconnaissance, Surveillance, and Arms Control, Adelphi Paper No. 88, (London: The International Institute of Strategic Studies, 1972), p 18.

indicating that,

> "...the Air Force favours intensive study and vigorous investigation to devise means to attack hostile missiles at their most vulnerable time of flight - as soon as possible after launch, before burnout and prior to the time when the warhead has separated from its booster. An active missile defense of this type appears to provide the greatest hope of an effective counter to the ICBM threat. As part of this larger effort, the Air Force now has under development the Missile Defense Alarm System (MIDAS) which will consist of satellites...capable of detecting missiles just after launch, while in their boost phase."[1]

Thus, in the early phases of its development, the MIDAS programme was very closely associated with the initial proposals for an American ABM system. As with many other systems closely related to specific command and control functions, the early warning satellite was identified and in fact justified in terms of functions largely unrelated to the ultimate purpose of the system.

The first MIDAS satellites were placed in orbit in 1960. The initial series of tests revealed several technical difficulties with the satellites - particularly those concerned with the infra-red sensors' ability to distinguish between different sources of thermal radiation, such as missile exhaust or sunlight reflected from clouds.[2] Not surprisingly, McNamara had serious reservations about the Air Force programme he had inherited from the previous administration. In the spring of

---

1 Department of Defense, <u>Annual Report, FY 1961</u>, p 316.

2 Philip J.Klass, <u>Secret Sentries in Space</u>, (New York: Random House, 1971), p 175.

1961, he testified before a Congressional committee that, "...The problems (with MIDAS) have not been solved and we are not prepared to state when, if ever, they will be solved."[1] By late 1961, the Defense Department had sharply curtailed the MIDAS programme after only five verified launches.[2]

Interest in applying the latest satellite technology to the problem of early warning of an ICBM attack did not fade completely, despite the difficulties which had plagued the early MIDAS programme. Apparently, "MIDAS-type" instruments were carried aloft on-board other satellite packages as part of an interim early warning satellite programme.[3] Meanwhile research and development efforts directed toward improving infra-red sensor capabilities continued. By late 1966 enough of the earlier problems had apparently been solved that the Air Force decided to select Thompson-Ramo-Wooldridge Systems (usually referred to as TRW) to develop an operational early warning satellite under the aegis of Project 949, variously referred to as the Early Warning Satellite System, or the Aerospace Surveillance System. At the same time, Aerospace General was awarded a contract to develop infra-red sensors for the satellites, while General Electric was named to design a television camera for the system.[4] The TRW satellites were

---

1 Quoted in "Problems Marked Early Satellite Effort", Aviation Week and Space Technology, September 20, 1971), p 19.

2 Greenwood, op. cit., p 18.

3 ibid.

4 Aviation Week and Space Technology, September 20, 1971, p 19.

to operate on the following principle: first, the infra-red sensors would detect thermal activity that might constitute a missile launching. Then, the satellite's television camera would be turned on to allow ground observers to visually observe whether or not a missile launching had in fact occurred. In this way, the difficulties which had been encountered with the infra-red sensors in 1960 could to some extent be obviated.

The TRW satellites, subsequently dubbed Project 647 or the Defense Satellite Program were developed in two phases. The initial launches of the Phase I satellites were reportedly unsuccessful. However, by May 1971 a pair of the 647 satellites were in operation in a geosynchronous (stationary) orbit over the Indian Ocean. Deliveries of an improved Phase II satellites were subsequently begun in February 1973.[1] In the FY 1975 annual report, Secretary Schlesinger indicated the U.S. now maintains on station one early warning satellite over the Eastern Hemisphere and two over the Western Hemisphere.[2] Information from satellites is relayed via communications satellites to two ground receiving stations - near Woomera, Australia, and Denver, Colorado - where it is processed and correlated by computers with intelligence information regarding the launch characteristics of potential enemy missiles.[3]

---

1 "Additional Warning Satellites Expected", (Aviation Week and Space Technology, May 14, 1973), p 17.

2 Department of Defense, Annual Report, FY 1975, p 72.

3 Barry Miller, "U.S. Moves to Upgrade Missile Warning", (Aviation Week and Space Technology, December 2 1974), p 16.

The Air Force is now considering the possibilities of providing its early warning satellite system with even more sophisticated warning capabilities, including reducing the 90 seconds it currently takes from the time a missile is launched until it is detected by the satellites. Plans have also been made to develop transportable processing systems to replace the present ground-based processing centres which are highly vulnerable to an enemy attack. Such processing systems might even be placed on the advanced airborne command post (which will be discussed in Chapter Five) in order to enhance the survivability of the early warning capability afforded by the early warning satellites in the event of a nuclear war.[1]

Over-the-Horizon Radar

The second approach which was adopted by the Air Force to increase the warning time which would be available in the event of an ICBM attack, involved the exploitation of a technological innovation known as over-the-horizon radar. The "forward scatter" version of OTH radar operates on the principle that bouncing radio waves off the earth's ionosphere at extremely long ranges allows for the detection of anomolies in the upper atmosphere which could, for example, be induced by a missile passing through it.[2] Using this principle, an OTH radar would ostensibly be capable of detecting missiles immediately after

---

1 ibid., pp 16-18.

2 Department of Defense, Annual Report, FY 1964, p 18.

they had been launched and, in the case of a Soviet ICBM attack against the United States, would almost double the warning time afforded by the BMEWS radars limited to "line of sight" detection.[1] Thus, the OTH radar system would be comparable to the satellite system in terms of the actual warning time afforded, and in some respects might be considered a duplication of effort and expense. However, as was noted above, the early warning satellite was plagued with technical problems throughout most of the 1960s, during which time the decision to proceed with OTH system was made.

Development of the OTH technique for strategic purposes was first publically announced by President Johnson in September 1964, in the wake of claims by the Republican Presidential candidate, Senator Goldwater, that a Democratic administration had made no significant strategic initiatives during its four years in office.[2] That same year the contract for developing an initial OTH system was let to Ratheon and Sanders Associates, under the heading of Air Force programme 440L.[3]

The testing and development schedule of the OTH radar system was markedly accelerated in 1967 in response to Pentagon fears regarding the possible emergence of a peculiar, new Soviet strategic threat. On November 3 of that year, McNamara announced in a press conference that the Soviets were developing what he termed a "Fractional Orbitting Bombardment System (FOBS)." Such a capability, McNamara warned, would allow the

---

1 *ibid.*, p 319.

2 *New York Times*, September 18, 1964, pp 1 and 20.

3 Greenwood, *op.cit.*, p 17.

Soviets to launch warheads at the U.S. in depressed trajectories over either pole which would not be as easily detected by BMEWS as a "standard" high trajectory ICBM launch. McNamara stated, in fact, that a FOBS attack might reduce the tactical warning time which could be provided by the BMEWS to less than five minutes.[1] Although the OTH radars had apparently originally been conceived as a supplement to the BMEWS which would increase the overall warning time of a "standard" ICBM attack from the Soviet Union, its unique characteristics apparently endowed it with a capability to detect a possible FOBS attack.[2] In 1967, the OTH radar system was still very much in the development stage, although it had reportedly performed as well or better than expected. However, using the rationale of a potential Soviet FOBS capability, the OTH system was quickly made operational, and by February 1968, the system was already in use by NORAD, albeit on a limited scale.

The urgency which greeted initial U.S. fears about a Soviet FOBS capability eventually receded, and while the OTH radar system was still considered important as a means of detecting depressed trajectory attacks, the OTH came to be perceived primarily as a supplementary component of the entire U.S. early warning system.

In the FY 1976 annual report, released in February 1975, Secretary Schlesinger announced that the over-the-horizon radar system was being phased-out. According to the report, the OTH had been plagued with a number of technical difficulties

---

1 New York Times, November 4, 1967, pp 1-2.

2 ibid., Also, Department of Defense, Annual Report, FY 1967, p 303.

resulting from atmospheric disturbances. Given the difficulties associated with the system, as well as the successful deployment of an early warning satellite system, the Pentagon had obviously concluded that the costs of operating the OTH radar system could no longer be justified.[1]

Warning of Sea Launched Ballistic Missiles

By 1963 or 1964 even another strategic threat began to loom in the calculations of Air Force systems planners. The International Institute of Strategic Studies reports that in 1960 the Soviet Union had not yet deployed any sea-launched ballistic missiles (SLBM). However, by 1962, it apparently had "Some" and by 1964 that number had jumped to 100.[2] Significantly, none of the U.S. early warning systems (except for the early warning satellites which did not become an operational reality until sometime after 1971) were configured to detect SBLM launches. BMEWS had been designed to detect mass missile launches over the North Pole. The OTH system, on the other hand, comprised transmitting stations in the Far East and receiving stations in Western Europe,[3] thereby suggesting that it was capable of detecting only those missiles that would have been launched between those two points, namely the Asian and European land masses.

---

1 Department of Defense, Annual Report, FY 1976, p II-48.

2 International Institute for Strategic Studies, The Military Balance, 1969-1970 (London, 1969), p 75.

3 Greenwood, op.cit., p 17.

Even though the Soviets had not yet begun to deploy SLBMs in any significant numbers, the Air Force had begun to study the warning problems created by SLBMs at least as early as April 1962.[1] From such Air Force studies emerged a proposal to develop a system specifically designed to provide tactical warning of an SLBM attack. The actual Air Force proposal suggested that a strictly interim SLBM detection capability could be provided by making the necessary modifications of the large SAGE radars which were being phased-out of their bomber detection role. The interim proposal, designated 474N by the Air Force, was approved by McNamara in November 1964, and the modification of six SAGE radars on both the Pacific and Atlantic coasts, plus the construction of a new site on the Gulf coast was begun.[2]

When the satellite early warning system finally became operational, it was subsequently identified as having the primary responsibility for the detection of SLBM launches. Secretary Schlesinger reported in 1974 that the Western hemisphere satellites were supposed to provide the first warning of an SLBM attack against the U.S. with complementary coverage provided by the 474N system. At the same time Schlesinger expressed some misgivings about the current U.S. SLBM detection capability:

---

1 Department of Defense, <u>Annual Report, FY 1968</u>, p 403.

2 <u>ibid</u>.

"Unfortunately, these 474N radars...have limitations against Soviet SLBMs...particularly the new long range SS-N-8. Moreover, there are a number of limitations in the current satellite coverage, it does not fully encompass all of the areas from which the SS-N-8 could be launched, it is susceptible to temporary solar induced outages which may cause some loss of coverage in those areas not covered by both Western Hemisphere satellites, and it is not entirely free of false alarms. To provide full coverage of the SLBM threat area, and to insure prompt verification of satellite data, we must have a more effective and reliable complementary warning system than 474N radars."[2]

In keeping with the pattern which had been established with the previous warning systems, the Pentagon response to the threat caused by the Soviet development of new delivery system - in this case the SS-N-8 - was to recommend an entirely new early warning system. In the case of the long range SLBM threat, the Defense Department has suggested that the 474N radar system be replaced with the two new, so-called SLBM Phased Array Warning Radars, which have been described as being more reliable.[2] Schlesinger accordingly recommended in early 1974 that funds for the phased-array radar systems be approved by Congress. The following year Schlesinger reiterated his recommendation to develop an East and a West Coast phased-array radar system for the detection of SLBM launches. In addition, he announced

---

1 Department of Defense, Annual Report, FY 1975, p 72. In the fall of 1974, the Soviets reportedly test fired an SS-N-8 SLBM for a distance of some 5000 statute miles, the longest firing of an SLBM for any nation. The range of the U.S. Poseidon SLBM, for example, is about 2800 statute miles.

2 ibid., p 73.

that plans had been made to, 1. phase-out a 474N stand-by radar on the East Coast, 2. to close down the 474N radar site on the Gulf Coast (Laredo, Texas) and to replace it with a Space Track radar in Eglin A.F.B., Florida modified for the SLBM detection role, and 3. to phase-out the BMEWS radar site at Clear, Alaska, if it could be established that its functions could be assumed by the West Coast phased-array radar. Schlesinger's rationale for implementing these "cuts" prior to the actual deployment of a phased-array radar system was to save the costs involved in the operation of these systems - a theme which pervades much of the most recent Defense Department annual report.[1]

The NORAD Command and Control System

While each of the early warning systems described above were developed more or less independently of one another and by virtue of their respective technical characteristics possess different capabilities, in the event of a nuclear attack on the United States each system's informational output would in effect be used to supplement the information provided by the others. The data supplied by each of the sensor systems is relayed by a variety of communications links to the North American Air Defense Command's Combat Operations Center (NORAD COC) located in a hollowed-out mountain in Colorado. There computers process the information from each of the early warning sensors and display the relevant facts on large computer-operated display panels.

---

1 Department of Defense, Annual Report, FY 1976, p. II-49.

The information provided by each system is in fact displayed "side-by-side", which allows observers in the NORAD COC to cross reference the output of each system.[1]

The development of the NORAD computers to process and display the information provided by the early warning systems as well as their location in Cheyenne Mountain (all of which was completed in 1967), itself constituted an Air Force "L" system, specifically the NORAD Command and Control System (425L).[2] Like the SAGE system of the previous decade, the 425L System was designed to apply the most modern automatic data processing equipment and techniques to process information provided by remote electronic sensors in order to provide military decision-makers as rapidly as possible with relevant and understandable information regarding a situation which was not directly observable by them. As will be discussed in greater detail in Chapter Five of this study, the same information which is processed and displayed in the NORAD COC is also immediately available to the various SAC alternate command posts and the National Military Command Center in the Pentagon by separate links to the sensor systems themselves, as well as to the 425L NORAD Command and Control System.

Strategic Doctrine and the Early Warning Systems

From the above discussion of the actual U.S. early warning systems, it is possible to draw several conclusions regarding the

---

1 Carmichael, op.cit., p 1

2 Department of Defense, Annual Report, FY 1967, p 16.

relationship between the development of the early warning systems and the issue of alternative strategic nuclear doctrines. In short, nothing in the development programmes of the individual systems which is available in open sources or in the circumstances surrounding them, suggests that the question of strategic flexibility was a factor in the design or the eventual decision to deploy the systems. To a certain extent, this conclusion logically follows from the relationship of the tactical warning function itself and the spasm and selective response doctrines. As noted in the previous chapter, the early warning function is a common element (in fact the only common element) in the command and control requirements for the implementation of both doctrines. Further, there is no differentiation in the tactical warning function requirements as defined for either doctrine. In other words, the proponents of virtually every variant of strategic nuclear doctrine have been able to agree on the need for timely and unambiguous tactical warning of an attack upon the U.S.

The decision to design and deploy particular early warning systems appears to have been motivated primarily by dissatisfaction with capabilities of existing systems to adequately cope with the threat perceived to be posed by potential Soviet strategic weapons capabilities. The role of the perceived threat as an impetus and justification for early warning systems development is clearly evident in each of the systems discussed above - as for example, in the Gaither Committee's recommendation to immediately begin development of a missile early warning system based on estimates of the Soviet ICBM development programme, as well as in the marked acceleration of the over-the-horizon

radar development programme in 1967 which resulted from fears that the Soviets were intending to deploy a fractional orbital bombardment system. As such, the development of early warning systems represents perhaps one of the few instances in the history of U.S. military systems development in which an almost direct relationship between the analysis of the treat and the decision to deploy a particular system can be demonstrated. One exception to this general observation is, however, provided by the example of the early warning satellite programme. The Air Force had clearly envisioned a wider purpose for the MIDAS programme than the early warning of missile attacks - namely, active anti-missile defense. Thus, in this case, the development of a particular early warning system cannot be explained exclusively in terms of a decision to develop a system to provide warning of an attack by a particular enemy weapon system.

The actual manner in which the perceived need to provide a warning capability against a particular strategic threat manifested itself in an actual system was in large measure determined by the possibilities afforded by the current technological state of the art. BMEWS, for example represented an extension of conventional radar capabilities, but was made possible only by on-going research conducted by the Air Force to improve existing capabilities, which in fact preceded the actual decision to develop a missile early warning system. In the case of the satellite early warning systems the basic concept was no doubt suggested by the most recent developments in the American space programme. The concept nevertheless proved to be beyond the technological state of the art at first, and the deployment of

an operational early warning satellite could not be achieved until further research and development had resulted in the infra-red and optical sensors needed to successfully implement the original concept. While these observations regarding the relationship between technology and the systems developed in response to a specific threat may seem at once obvious, the technological state of the art must nevertheless be recognized as a critical factor in the determination of the kinds of systems and system's capabilities which actually resulted from the original motivations to proceed with a particular development programme. As will be examined later in this study the actual technical characteristics of a particular system often provide it with capabilities which are in fact more extensive (or even unrelated) to those which could be considered necessary to the performance of its originally intended functions and which, furthermore, can be employed to perform other functions. This point is particularly important with respect to the means in which the current U.S. command and control systems have become related to the issue of strategic nuclear flexibility well after their respective development programmes were completed or already well underway.

The Early Warning Systems and the Attack Assessment Function

While one might well conclude that the rationale for the development of the various early warning systems was almost completely divorced from the issue of nuclear strategic alternatives at least in the early stages of the respective development

programmes, the early warning systems themselves (as opposed to the early warning function) have eventually become more closely associated with the question of strategic flexibility because of their direct relationship with the attack assessment function.

The distinction between tactical warning and attack assessment, as well as the latter function's relationship to the selective response doctrine were discussed in the previous chapter. Despite the fact that early warning and attack assessment imply conceptually different functions, the early warning systems described above are capable of providing at least some basic information regarding the nature and character of an enemy attack beyond simply indicating that an attack is in progress. In other words, they possess some attack assessment capability. BMEWS, for example, is capable of determining, in relative terms, the size of an attack. Although the system would be itself unable to determine the exact number of missiles involved in an attack (since the radars in Alaska and Greenland might count the same missiles), the system would at least be able to indicate whether the attack was relatively small and limited, or massive.[1] BMEWS is likewise capable of determining, again in rough terms, the area of the United States which would be under attack. By calculating the azimuth of the attacking missiles, BMEWS would allow decision-makers to determine if the incoming warheads were directed against the U.S. coastal areas - which contain the majority of the U.S. cities and industrial areas or, the Midwest where, for example, the U.S. Minuteman missile sites are predominantly situated.[2]

---

1 Interviews No. 19 and 21.

2 ibid.

The early satellite system as well as the various U.S. reconnaissance satellites would apparently be capable of providing even more precise attack assessment information than BMEWS, including: the exact number of missiles launched, the country from which the missiles were launched (including perhaps even the actual silos from which the missiles were launched), as well as some initial tracking information.[1] Furthermore, the satellites are also considered capable of providing damage and strike assessment information by, one, verifying that nuclear explosions have in fact occurred, and two, using their cameras to provide some indication of the kinds of targets that were attacked, as well as the level of damage.[2] Prior to the current generation of early warning and reconnaissance satellites, the damage assessment function would have ostensibly been performed by the so-called Nuclear Detection and Reporting System(NUDETS). NUDETS was developed by General Electric in 1963 for the Air Force as a follow-on system to the operationally unreliable Bomb Alarm System, already in existence. NUDETS consists of a series of sensing posts implanted throughout the U.S. On each of these posts are seismic, optical, and thermal sensors which are designed to automatically send an alarm signal to various command posts if a nuclear explosion occurs in the vicinity of the post. Computers at the command posts would reportedly be able to fix

---

1 Miller, op.cit., p 16. The various U.S. reconnaissance satellites are not discussed in this study. A detailed account of their development programmes as well as their respective capabilities is found in Klass, op.cit.

2 Interview No. 6 .

the location of the blast from the data received from various sensors.[1] The NUDETS sensors would, however, be quite vulnerable to the very explosion they were designed to detect, a problem which would be obviated to some extent in the case of the satellite systems.

As was concluded earlier, the decision by the Air Force and the Defense Department to develop the various warning systems was primarily motivated by a desire to improve existing capabilities to perform the tactical warning function. While they may have been designed to serve other purposes the technical characteristics which were built into them have provided them with some attack assessment capability. The amenability of the early warning systems to the performance of functions not intended in their original design is particularly evident in the case of the early warning satellites. One journal has reported that:

> "...The ability of the satellites to provide even course tracking information and to predict the missiles impact area was a surprise fallout from the programme, since the space craft were designed and optimized for detection, not tracking."[2]

However, it must still be noted that the early warning systems are not capable of providing all the information implied in the Air Force's attack assessment definition.

---

1 Science News Letter, December 28, 1963, p 404, and Stewart Alsop, "NUDETS - The Paradox of Horror", Saturday Evening Post, December 17, 1963), p 18. Also, Interviews No 2 and 6.

2 Miller, op.cit., p 2.

The Air Force Attack Assessment Programme

In 1970, the Air Force initiated several formal studies regarding its capabilities to perform various "missions" which it considered would be a necessary adjunct to its proper role in the coming decade. These studies reportedly reflected some concern with the direction of Soviet and Chinese nuclear weapons developments, as well as a recognition of certain changes in U.S. strategic policy which were being generated at the national level.[1] One such "mission analysis", entitled "Information Processing/Data Automation Implications for Air Force Command and Control in the 1980s (CCIP-85)", had been chartered by the Air Force Systems Command to identify future command and control requirements and to indicate the proper avenues for research and development efforts. The RAND and MITRE Corporations, as well as several Air Force agencies contributed to the study which was eventually completed in the spring of 1972. While much of the report remains classified, it apparently made specific references to President Nixon's expressed desire for an increased number of nuclear strategic options available to the President as the rationale behind many of its findings.[2] With respect to command and control capabilities the study group concluded, "Future strategies will not only require great flexibility, but also the ability to provide environmental information (from various

---

1 Carmichael, op.cit., p 2.

2 Edgar Ulsamer, "Command and Control Is of Fundamental Importance", (*Air Force Magazine*, July 1972), p 44.

sensor systems) rapidly and to adapt policy and tactics in near real time".[1]

The ideas and concepts manifested by CCIP-85 also found expression in a similar Air Force study which examined the means by which a formal attack assessment programme could be developed. In mid-1971, the Air Staff directed the Air Force Systems Command to prepare a development concept for such a system. The proposal which eventually emerged from the Air Force studies envisioned an attack assessment system in which automated data processing techniques could be used to derive attack assessment information from the data received from the existing early warning systems, which they, acting independently, could not provide.[2]

The Air Force attack assessment concept specifically involved two activities. The first concerned the integration of existing early warning sensor information to provide a clearer and more comprehensive "picture" of an attack than would currently be possible. As mentioned above, the information received from BMEWS and the other warning systems are all displayed in various command posts, although on separate screens. Since each system may detect the same individual missiles, the side-by-side display of information may not accurately reveal the precise size of the attack or detailed information about particular missiles, such as trajectory. According to the Air Force, however, a systematic integration of the existing data would result in: "a complete list of all missile flights observed (as opposed to gross count sensor observations), identification of missiles which are

---

1 Quoted in Carmichael, op.cit., p 2.

2 ibid., pp 3-6.

observed by more than one sensor and a refined knowledge of the missile trajectory characteristics which have been the object of multiple sightings."[1]

The second aspect of the attack assessment concept developed by the Air Force, suggests that information regarding the trajectory and other flight characteristics of attacking missiles which would be available from an integration of data from BMEWS and other early warning sensors could be correlated by a computer programme with already known information about the characteristics of potential enemy warheads and missiles.[2] Certain characteristics of Soviet missiles for example, are known to have been obtained from observation of Soviet missile tests.[3] Such information could conceivably be stored in a computer data base to be compared with trajectory information regarding attacking missiles to estimate the impact point of their warheads.[4] Such a system would thus provide for attack assessment information not provided directly by the sensors themselves or from an integration of their outputs - namely, weapon and payload identification, and class of targets under attack. Air Force officials admit that even with the above information it would still be quite difficult to determine precisely what targets were under attack, and, hence the nature and character of an attack. For example, if it could be determined that a particular warhead would impact in an area in which a military installation was located in the immediate vicinity of a large city, it would

---

1 ibid., p 4.

2 ibid.

3 Greenwood, op.cit.

4 Carmichael, op.cit., p 6.

still be difficult to determine whether that warhead had been targetted against the city or against the military installation.

Following the initial studies which resulted in the above attack assessment concept, the Air Force launched Phase I of its attack assessment programme, which had the expressed purpose of "...making the most of currently available sensor data."[1] The Air Force contracted TRW Systems to assist in the development of computer programmes to correlate the sensor data and equipment to display the attack assessment information at SAC Headquarters, the NORAD COC, and the National Military Command Center.[2] While the progress of Phase I has not been publically disclosed, the Air Force had suggested at the outset that the objectives of the attack assessment programme might not be met in their entirety by Phase I. Thus, plans had already been formulated for a Phase II which would involve a more precise definition of attack assessment requirements, as well as a Phase III to develop the system needed to implement this definition.[3] While the Air Force attack assessment programme has the support of the Department of Defense, it has encountered some opposition in Congress for its attack assessment programme in Fiscal Year 1973. Anticipating approval of the request, the Air Force awarded a $4.3 million contract to TRW Systems for its assistance in the programme. Congress, however, subsequently authorized only

---

1 "Computers Aid Attack Assesment Plan", (Aviation Week and Space Technology, February 4, 1974), p 15.

2 ibid.

3 Carmichael, op.cit., p 6.

$1 million for this purpose and the Air Force was forced to revise its arrangements with TRW.[1] The attack assessment system is reportedly still under study, although the progress of the programme has thus far not been disclosed.[2]

The Air Force attack assessment programme, is a particularly important aspect of the history of command and control development as far as its relationship to strategic alternatives is concerned. As was discussed in Chapter Two, the attack assessment function has been defined by command and control specialists as an integral, even vital, requirement for the implementation of a strategy of selective response. The purpose of the attack assessment function is to provide the information regarding the nature and character of an enemy attack which is relevant to the determination of the appropriate U.S. response. The relationship of the attack assessment function to the issue of strategic flexibility has been recognized and articulated since the early 1960s - as Benington's "Command and Control for a Selective Response", quoted earlier, suggests.[3] Discussion of the technical means by which an attack assessment capability could be achieved has taken place at least since then. Yet, the significantly increased emphasis on the issue of attack assessment represented by the formal Air Force attack assessment programme appears to have resulted primarily from the correspondingly increased emphasis on strategic flexibility which manifested itself in the 1969-1970 time period. While it would

---

1 Aviation Week and Space Technology, February 4, 1974, p. 15.

2 Interviews No. 4, 19 and 21.

3 Benington, op.cit.

be difficult on the basis of the existing evidence to establish an unambiguous causal relationship between the Nixon administration's renewed interest in the issue of strategic nuclear options starting in 1969 and the Air Force mission analyses studies which led to the current attack assessment programme, the Air Force has nonetheless justified its programme in terms of national policy decisions regarding strategic policy, suggesting that the impetus and the character of the programme is in large measure a response to the current plans reported by Secretary Schlesinger to increase the U.S. strategic nuclear flexibility. In this sense, the attack assessment programme serves as an example in which basic policy decisions regarding strategic doctrine serve as a primary though no necessarily a singly determinant factor in shaping the direction of command and control developments.

The attack assessment programme also suggests the importance of the technological dimension in the relationship between command and control systems development and strategic flexibility. Specifically, the Air Force programme would entail the use of existing systems in a role for which they were not originally designed, yet are nonetheless amenable. The possibility that the various early warning systems could be used for the attack assessment function results from the technical characteristics which were originally designed into the systems, perhaps without any consideration that these characteristics might lend the systems additional functions in the future.

CHAPTER FOUR

Controlling the Strategic Nuclear Forces

As was discussed in Chapter Two, the control of forces has been an important element in the conduct of military operations throughout history. The dispersal and range of the present-day strategic nuclear forces, as well as the difficulties that would exist in communicating with them in the event of a nuclear war, have created an unprecendented problem of control of forces. This chapter will discuss the various command and control and communications systems which the Air Force and the Navy have developed to monitor and direct their respective strategic forces. As will be examined below, one of the most difficult and central problems confronting command and control specialists in the design of these systems has been the extent to which they would survive the effects of a nuclear attack and thereby be capable of continuing to provide for the control of the strategic forces in a so-called "post-attack environment". The systems which have emerged after more than two decades of development will be shown to provide for a considerably more flexible use of the strategic forces than implied by the spasm response doctrine, although specific considerations of doctrine do not appear to have been a major factor in determining this result.

The SAC Command and Control System

Prior to the mid-1960s, the control of the forces of the

Strategic Air Command (SAC) was performed with a system which command and control specialists have today described as "manual".[1] Information regarding the status and actual disposition of SAC's bombers and relatively new missile force was in effect telephoned from the field to the SAC Headquarters command post located in a three-story underground complex near Omaha, Nebraska. Much of the information received by the command post first passed through several intermediate levels of authority before actually reaching Omaha. Without any automatic filtering process, masses of raw data converged on the human controllers in the command post who then had the task of sifting through it to find and present the information required by the SAC command staff in making decisions and directing the operations of the SAC forces. Such information was subsequently displayed on large panels mounted on trolleys which were wheeled in and out of the sight of the command staff as needed.[2] From the Headquarters command post, the SAC commander could reportedly make contact with any local SAC unit commander and local control rooms by means of a specialized telephone system.[3] The entire control system was exercised almost constantly and seemed to satisfy the demands imposed upon it by the stategic situation of the 1950s. For example, one industry trade journal reported that the system allowed the SAC commander to locate any crew at any time.[4]

---

1 Brig.Gen. Lawrence W.Steinkraus, "Command and Control", (<u>Ordnance</u>, March-April 1971), p 441.

2 <u>ibid</u>.

3 "The Red Telephone", (<u>Boeing Magazine</u>, July 1958) p 6.

4 <u>ibid</u>., p 7.

With the recognition of a potential Soviet ICBM threat in the late 1950s, SAC considered its existing command and control system to be wholly inadequate. In the event of a war involving nuclear-armed missiles, the time compression problem (discussed in Chapter Two) would create a situation in which the amount of information flowing into the SAC command post at any given time and subsequently required by the command staff would outstrip the the capacity of the controllers to receive, process, and display it. To cope with such a flood of information, SAC wanted a faster and more efficient command and control system. The solution to their problem was to be sought in the application of the most recent automated information processing equipment and procedures to perform many of the routine tasks then performed by human controllers.

In 1958, the Air Force selected ITT to develop an "...automated electronic system designed to transmit, process, and display information required by the commander-in-chief, SAC, and his staff, in the planning, direction and control of global peacetime and wartime operations of SAC."[1] This project was dubbed the SAC Automatic Command and Control System (SACCS, or 465 L). As with SAGE, the Air Force had contracted for the development of an entire, completed system - just as if it had bought an actual weapons system. In November 1961, International Electronic Corporation of Paramus, New Jersey, an ITT subsidiary, was awarded a $57 million contract to proceed with production of the system.[2]

---

1 Army, Navy and Air Force Journal, September 27, 1958, p 122.

2 Army, Navy and Air Force Journal, November 25, 1961, p 368.

The development of SACCS subsequently encountered a number of difficulties, one of which has been described as an inadequate appreciation of the changing character of SAC's forces - particularly the retirement of the B-47 bomber and the faster than expected introduction of ICBMs into the force structure.[1] A second problem which reportedly plagued the SACCS development programme involved an increase in the number of functions the system was designed to perform. SACCS was originally programmed to facilitate the direction and alerting of the forces, and the conduct of actual operations. A second function was, however, added well after the project was already underway - namely, the use of the SACCS computers to aid in planning war options.[2] As Licklider has reported,

> "The development of SACCS updated the computer programming experience gained in the SAGE system. It showed dramatically that you can pour more and more men and money into it without causing it to be completed. The computer programmes get more and more complicated but not more and more operable. You begin to understand the possibility that they may literally be "debugged" and integrated."[3]

Thus, although the system was "turned-on" as early as 1964, SACCS did not become fully operational until 1967, and significant modifications were even then still in progress.[4]

Without explaining the detailed structure and operation of

---

1 "How Not to Build a C & C System Is Still an Unanswered Question in Defense", (Armed Force Management, July 1966), pp 109-112.

2 ibid.

3 Licklider, op.cit., p 123.

4 "SAC Control System," (Ordnance, November-December 1964), and Department of Defense, Annual Report, FY 1967, p. 364.

the system,[1] SACCS in effect serves to provide for the direct and instantaneous relay of information regarding the operational status and location of each element of the SAC forces to the SAC command post in Omaha. There computers automatically process this information and visually display the relevant items for the SAC command staff on large electronic, computer-driven display panels, or on computer "print-outs". In short, SACCS allows the SAC command staff to know just what forces are available for particular operations. The SACCS is also employed to transmit orders from the SAC Headquarters command staff directly to the forces.

SACCS' role since its inception has, obviously, been devoted to the routine, day-to-day monitoring of the status of SAC's widely dispersed aircraft and missiles. The system is likewise used to evaluate the performance of SAC's combat crews in training exercises which are designed to simulate actual general war operations. A former SAC commander reportedly once argued that in his opinion the main purpose of SACCS was to assist in the conduct of such training exercises which would insure that in the event of an actual nuclear war the SAC crews would by force of habit correctly perform their assigned missions, even if SACCS did not survive the nuclear exchange.[2]

---

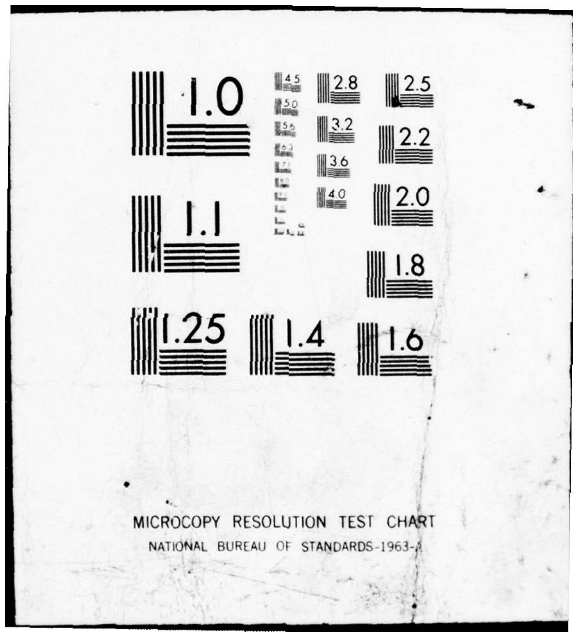
1 Such details can be found, for example, in David W.Townsend, Jr., "What Hath SACCS Wrought", (Combat Crew, January 1972), pp 10-13.

2 Interviews No. 6 and 24.

AD-A045 180 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO F/G 15/3
U. S. STRATEGIC DOCTRINE AND THE DEVELOPMENT OF COMMAND AND CON--ETC(U)
APR 75 F G KLOTZ
UNCLASSIFIED AFIT-CI-77-3 NL

2 OF 2
AD
A045180

END
DATE
FILMED
11-77
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SACCS and Strategic Flexibility

Several command and control specialists have suggested that SACCS was developed primarily to facilitate the conduct of what had previously been an extremely complex management problem, namely, the constant monitoring of the status and whereabouts of the SAC forces.[1] This observation is not contradicted by the open literature concerning SACCS in the early stages of its development programme. Whatever the original intentions of the Air Force with respect to its purpose and design, because of its technical characteristics and capabilities SACCS can at the same time be considered as a necessary and useful device for increasing the flexibility with which the SAC forces can be employed.

In Chapter Two, the massive or spasm response was described as a strategy in which political considerations were no longer relevant to the conduct of nuclear war and strategic forces would be delivered as quickly and effectively as possible to inflict maximum damage on the enemy. If the sole function of the SAC forces in the event of a nuclear war were to implement a spasm or massive response strategy, then SACCS would serve no purpose beyond that which the SAC commander cited above claimed for it - namely to train SAC crews to launch their weapons. Once the order to launch a massive strike had been given, the entire SAC force (with the exception of a possible reserve force) would presumably proceed to attack the targets

---

1 <u>ibid</u>.

assigned to them in the SIOP. There would thus be no need to continue to monitor the status of the forces in this situation, since the strategy by definition does not envision the issuance of any further orders to the forces after the initial decision to attack has been made.

However, in the case of the more flexible selective response strategy, the capabilities afforded by SACCS for the command and control of the SAC forces would be essential throughout the course of a nuclear war. The selective response strategy implies that the SAC forces would be employed in less than total numbers to attack specifically defined targets in order to implement particular kinds of attack options. Presumably, the forces to be used and the targets to be attacked in a given option would have already been preassigned within the context of the SIOP. In theory at least, SACCS could be employed to provide for even more flexibility than is suggested by the option structure of the SIOP. With SACCS, the SAC command staff would presumably know the location and disposition of the SAC forces during a crisis, and thus would also know which forces were available to attack particular targets. Furthermore, the SACCS computers are reportedly programmed to match the conduct of actual operations with the pre-war contingency plans.[1] Thus, SACCS would presumably be capable of informing the SAC command staff when deviations from the operations had occurred due to launch failures, destruction of U.S. forces by enemy attacks, etc. One is tempted to conclude that with the information concerning the status of the SAC forces and the success

---

1 Ordnance, November-December 1964.

rate in implementing the SIOP which are provided with the SACCS information processing capabilities, that the SAC command staff would be able to perform the necessary calculations to assign specific forces to specific targets (that were either not originally included in the SIOP or were not attacked, even in the implementation of a SIOP option, because of launch failures) during the course of a nuclear war.

This degree of strategic flexibility has been variously referred to by command and control specialists as an "ad hoc" or "real time" targetting capability. It represents perhaps the ultimate in strategic flexibility. There appears, however, to be some debate among Pentagon officials as to whether a "real time" targetting capability is either necessary or desirable. Schlesinger, for example, at one point has argued that the President should have the option of limiting strikes down to a few weapons, but

> "...in order to have that kind of capacity one has to do the indoctrination and the planning in anticipation of the difficulties involved. It is ill-advised to attempt to do that under the press of circumstances. Rather one should think through the problems in advance and put together relevant, small packages which a President could choose under the circumstances in which they might be required..."[1]

In other words, Schlesinger appears to have indicated that even the most limited nuclear attack options should be included within the pre-planned structure of the SIOP.

However, some Department of Defense and Air Force officials have argued that an ad-hoc or real-time targetting capability

---

1 U.S. Congress, Senate, op.cit. p 9.

is desirable in terms of the flexibility that it would ultimately afford and that current command and control developments are in fact definitely pointed in the direction of achieving such a capability.[1] Even Schlesinger's comments seem to indicate agreement on this point, in contradiction to his remarks quoted above. For example, in discussing the kinds of command and control capabilities which it might be necessary to include on the advanced airborne command post (which will be discussed below), Schlesinger stated in the FY 1975 report that,

> "...If the NCA (National Command Authority) is to be in a position to exercise a choice among a wide range of nuclear response options, including some which may not have been preplanned, the data required aboard the aircraft would be quite extensive." (my emphasis added)[2]

In the final analysis then, the degree of force control flexibility implied by a real-time targetting capability has not unequivocably been ruled out by the Defense Department and the Air Force as a goal to be pursued in command and control development.

To return to the discussion of actual command and control systems, SACCS, which was designed to monitor the status of SAC forces and direct those forces in the conduct of their operations, provides the capabilities required to direct the forces to implement particular options included within the SIOP. Furthermore, SACCS could potentially be employed to achieve even more flexibility of control than is now available by providing the information and calculations which would be necessary to attack targets

---

1 Interview No. 6 and 12, for example.

2 Department of Defense, Annual Review, FY 1975, p 76.

not included within a specific SIOP options or to assume the targets of forces which were destroyed or unsuccessfully launched. The degree of control which SACCS now exhibits, and could possibly possess in the future, is however governed by three further considerations: one, the extent to which the SAC command staffs and the command and control capabilities made available to them by SACCS' electronic hardware would survive a nuclear attack; two, the extent to which the means of communicating with the forces would survive a nuclear attack; and, three (in terms of potentially more flexible uses of the SAC command and control system discussed above), the extent to which the forces themselves are retargettable. Each of these issues will be discussed in turn.

The Survivability Issue: Command Posts

The survivability of strategic command and control and communications systems in the event of a nuclear war has represented perhaps the most central concern of military and civilian command and control specialists since the early 1960s. According to one command and control specialist, prior to 1960 many Air Force officials has assumed that even in the midst of a nuclear crisis one could pick up a telephone and call wherever one wanted.[1] However, by 1960 a series of detailed studies regarding the probable physical effects of nuclear explosions, sponsored in large part by the RAND Corporation had drawn considerable attention to the question of the capacity of the strategic

---

1 Interview No. 9.

forces and their command and control systems to survive a nuclear attack. This concern with the survivability of the strategic force structure eventually manifested itself at the highest levels in the Pentagon.[1] For example, only a few weeks after taking office, Secretary McNamara directly addressed the survivability issue, linking the credibility of the U.S. nuclear deterrent to the ability of the U.S. strategic forces to survive a surprise attack:

> "In this age of nuclear armed intercontinental ballistic missiles, the capability to deter rests heavily on the existence of a force which can weather a massive nuclear attack, even with little or no warning, in sufficient strength to strike a counter-blow. This force must be of a character which will permit its use, in the event of attack, in a cool and deliberate fashion and always under the complete control of the constituted authority."[2]

In a speech in Chicago the following year, McNamara specifically linked command and control systems to the survivability issue, claiming:

> "It is not enough, however, for us to have weapons that can survive an enemy attack and that can penetrate enemy defenses. In a world in which both sides must be capable of inflicting severe damage on each other, we must have the machinery for command and control of our forces, which is itself able to survive attack and to apply the surviving forces in consonance with national security operations."[3]

In this same speech, as well as in others, McNamara identified survivable command and control systems as necessary adjuncts

---

1 Enthoven and Smith, op. cit., pp 166-7.

2 Quoted in Kaufmann, op. cit., p 53.

3 Quoted in ibid., pp 74-5.

to a selective response capability. Quite simply a selective response strategy could not be implemented without a command and control system which would survive to facilitate the process of making of necessary decisions regarding particular response options and of directing the forces to carry-out those options.

However, McNamara's interest in command and control survivability apparently involved more than just concern for the ability of the U.S. strategic forces to conduct particular kinds of strategic options. It had a definite political dimension as well. Specifically, McNamara also viewed a survivable command and control system as essential for maintaining civilian control over strategic nuclear weapons in the event of a nuclear war. The alternatives to maintaining a survivable system of some sort were either to accept the possibility that no U.S. response to an attack would be made or to pre-delegate the authority to use nuclear weapons to lower levels of command. Neither prospect appealed to McNamara or to President Kennedy.[1] The first allegedly lessened the credibility of the U.S. nuclear deterrent by implying that a first strike by the Soviet Union might not be answered by a U.S. retaliatory strike. The second reduced the degree of control the President could maintain in a crisis and increased the risks of an accidental or unauthorized nuclear attack. The first two years of McNamara's years in the office of Secretary of Defense witnessed then the initiation of several projects designed to enhance the survivability of the strategic command and control capabilities.

---

1 Interviews No. 12 and 15.

The emphasis on survivable command and control at the highest national political level was reflected in SAC with the first depolyment of an airborne SAC command post starting in February 1961.[1] Command and control specialists have long held that there are essentially three means to enhance the survivability of a particular system: one, to build several different systems each capable of performing the same functions so that if any one of the various systems is destroyed the others can take-over; two, to design the systems in such a way that they can physically withstand the effects of nuclear weapons; and, three, to provide the system with a means of movement so that a potential enemy could not pin-point its location in order to attack it, or so that the system itself could be moved to an area considered to be safe from attack. In U.S. military jargon, these survivability concepts are generally referred to as redundancy, hardening, and mobility, respectively. The SAC airborne command post in effect combines the redundancy and mobility concepts. Known as the <u>Looking Glass</u>, it is located on-board a modified Boeing KC-135 tanker aircraft. At least one <u>Looking Glass</u> is airborne at all times, carrying a battle staff under the direction of a general officer. This battle staff is capable of communicating directly with the primary SAC command post located in Omaha, as well as additional ground-based alternate SAC command posts. Furthermore, the <u>Looking Glass</u> can reportedly communicate directly with all SAC forces, and the National Military Command Center in the Pentagon. In the event that the primary and

---

1 <u>Military Review</u>, October 1964, p 102.

alternate ground-based SAC command posts were destroyed, the Looking Glass has been designed to assume control of the SAC bomber and missile forces.[1]

In 1962, the operation of the "Looking Glass" was subsumed under a concept known as the Post-Attack Command and Control System (PACCS). The concept became defined in terms of an Air Force programme with the same name (481L) which was intended to develop the appropriate technical means to insure that the control of the SAC forces could be maintained even after an attack.[2] As such, the Air Force's PACCS concept was directly related to McNamara's expressed desire for "machinery for command and control of our forces, which is itself able to survive attack and to apply surviving forces." The very development of a system for the post-attack command and control strategic forces reflected the shift in emphasis away from the more automatic spasm response of the Fifties to a nuclear attack toward a more controlled reaction to events that had taken place in declared U.S. strategic doctrine in the 1961-62 period.

PACCS apparently did not envision the construction of an entirely new and separate system, as had been the case with SAGE and SACCS, for example. Rather, the Air Force had intended to develop PACCS using "off-the-shelf" capability for the system. This kind of evolutionary approach to development, incidentally, characterized much of the subsequent command and control development efforts in other areas. PACCS did not, however, generate much enthusiasm of its own - perhaps, as had been reported,

---

1 Aerospace Digest International, April 1965, p 45.

2 Aviation Week and Space Technology, April 8, 1963, p 8.

because of the difficulties of developing and funding a system for an eventuality which most observers consider quite remote and about which very little can be known.[1] Furthermore, a declining interest in the problem of post attack command and control significantly coincided with the decreasing emphasis on strategic options which characterized McNamara's discussion of strategic nuclear doctrine after 1963. Despite any clearly defined end-product and a lack of understanding and support, PACCS continued to exist, at least as a concept, and to provide the justification for several smaller scale efforts by the Air Force.

In the mid-1960s the Air Force initiated several programmes to increase the capabilities of the Looking Glass as part of a longer term trend of providing the airborne command post with more of the command and control capabilities available to the primary SAC command post. One such project was the development of the Airborne Launch Control System. Although very little unclassified literature has been written about this particular system, it is known that it would allow the airborne command post or its various relay aircraft to launch SACs Minuteman missiles from their silos.[2] The launch of a Minuteman would normally be directed from underground launch control centres (LCC's) located near the actual missile silos. Each LCC's has control over ten missiles. The LCC's of a particular missile base are inter-netted in such a way that in the event that several of the LCC's are destroyed, one LCC could launch up to

---

1 Armed Forces Management, July 1966, p 92.

2 ibid.

50 missiles. If all the LCC's for a particular site became inoperative, the Airborne Launch Control System would allow Minuteman crews aboard the Looking Glass and its communications relay aircraft to launch the missiles from their silos - under the conditions that all electronic signals from the LCC's to the silos had ceased.[1] The Airborne Launch Control System was also ostensibly defined in terms of the PACCS and reportedly consumed most of the $10 million budgetted in the FY 1967 PACCS programme as part of a concerted overall effort to minimize the links between the emergency command post of SAC and the weapons themselves.[2]

The equipment actually on-board the Looking Glass has also been subject to a series of modifications and improvements, particularly in the area of communications capabilities.[3] Despite the improvements which have been made aboard the Looking Glass, Air Force officials nevertheless contend that its actual command and control capabilities remain somewhat limited compared to the capabilities of the ground-based command posts. In 1971, one military "trade journal" reported that:

> "In Looking Glass much of the necessary command and control data is in book form. Research is manual. Each member of the flying battle staff has his own reference volumes and must research information needed during the mission. The on-board computer tapes are loaded before take-off. New information cannot be updated automatically, but must be inserted manually."[4]

---

1 Interviews No. 6 and 18.

2 Armed Forces Management, July 1966, p 92.

3 Details of these modifications are discussed in Military Review, October 1964, p 102; Aerospace Digest International, April 1965, pp 45-6; and Armed Forces Management, April 1968, p 116.

4 George Weiss, "Restraining the Data Monster: The Next Step in C^3," (Armed Forces Journal, July 5, 1971), p 28.

Command and control specialists have argued that the degree of flexibility with which an airborne command could control the SAC forces in the event of a nuclear war depends upon the extent of its information processing capability. As was discussed earlier in this chapter, the ground-based SACCS with its extensive and sophisticated computer equipment affords the command staff in the primary SAC command post a considerable degree of control, and hence flexibility over the SAC forces. Sometime in the late 1960s, SAC started a programme to test the feasibility of providing Looking Glass with its own, on board automatic data processing capability. This project, known as SAC Airborne Data Automation, analyzed the procedures and requirements involved in up-dating the Looking Glass computer's data base via a direct link to the primary SAC command post computer.[1] The long term trend apparently envisioned by SAC has been to provide the SAC airborne command post with much the same command and control capabilities as the SAC command post near Omaha, and thereby increase the probabilities that the capability and flexibility associated with the ground-based system would survive a nuclear attack.

The extent to which the potential afforded by automated data processing techniques could be realized in an airborne command post is, according to Air Force officials, severely limited by the size of the EC-135 aircraft now being used.[2] This consideration has in turn led to efforts by the Air Force to acquire a larger command post aircraft which could accomodate

---

1 ibid.

2 Edgar Ulsamer, "Nuclear-Proof Flying Command Post", (Air Force Magazine, July 1973), pp 64-5.

additional electronic hardware, as well as the larger staff needed to operate it. Since the efforts to develop such an advanced airborne command post" for the Looking Glass role is intimately related to a similar effort regarding the airborne command post for the National Military Command System, a more detailed discussion of both is postponed until the following chapter.

The Survivability Issue: Communications

SAC's efforts to improve the survivability of its command and control capabilities has also concerned the means by which its various command posts would communicate with the forces themselves. Communications are "vulnerable" to nuclear attack in at least two distinct ways. First, the electronic systems involved in the transmission and receiving of communication signals are themselves vulnerable to the blast, heat, pressure, and electromagnetic pulse produced by nuclear weapons explosions. This latter effect, EMP, refers to a physical phenomenon of nuclear explosions which has the effect of inducing large voltage surges in some types of electronic equipment which can cause extensive damage to those systems. A single high-altitude nuclear explosion could reportedly cover the entire United States with an EMP on the order of 50,000 volts per metre electric field strength - roughly 300 times stronger than a radar beam of sufficient intensity to cause blindness or sterility.[1] The

1 Major George A.Kuck, "Nuclear Weapon Induced Electromagnetic Pulse Effects and AF Systems", Air Command and Staff College, Maxwell A.F.B., Alabama, April 1974 (Unpublished paper), pp 1-2.

effects of EMP on electronic systems can be mitigated by incorporating several design features into the systems. However, since most Air Force electronic systems were developed before the implications of EMP were fully understood, such design features were often not specifically considered in their development.

Second, the communication signals are subject to so-called "black-out" effects which would disrupt their effectiveness in a so-called "nuclear environment". Certain radio frequencies are, however, less susceptible to these effects - particularly, the higher frequencies (HF, UHF) and the lower frequencies (VLF, SLF, and ELF). The former, however, suffer from the disadvantage that they are restricted to line-of-sight communication and the latter require relatively large and therefore vulnerable transmitters and receivers to be effective.[1] The Air Force has initiated several varied projects in the last ten years to enhance the survivability of its strategic communications capabilities. For example, the first Looking Glass airborne command posts were equipped with high frequency (HF) radios to transmit orders to the SAC forces. In 1962, ultrahigh frequency (UHF) radios were added to the HF sets already on-board. UHF communications are considered to be more survivable than HF. However, UHF is characterized by much shorter effective ranges than HF, and the incorporation of UHF communications on the Looking Glass required the Air Force to employ communications relay aircraft with the Looking Glass to insure that messages could reach all of SAC's forces.[2]

---

1 Lt.Col. John B.Tindall, et al., A Primer in Strategic Command and Control Communications, Research Report 73-5, U.S. Air Force Academy, Colorado, June 1973, pp 28-58.

2 Aviation Week and Space Technology, April 8, 1963, p 8.

The Air Force has also developed a low frequency communications system to further enhance its capabilities to communicate with the strategic forces in the event of nuclear war. As mentioned above, low frequency communications are not restricted to line-of-sight, and are capable of much longer ranges than HF or UHF, as well as being relatively immune to vagaries of climate and atmospheric conditions. The Air Force began to study the feasibility of low frequency communication in 1961. It subsequently contracted Westinghouse to develop the SAC Survivable Low Frequency Communications System (SLFCS, or 487L) to provide links with the National Military Command Center, SAC Headquarters, the Looking Glass and the SAC forces. A completed system with its 1200 foot, "Eiffel Tower" antennae (near Omaha and Los Angeles) were turned over to SAC in 1967.[1]

The low frequency system is limited in the sense that it can only provide for one-way communication, with a very low rate of data at that. Every SAC command post and missile launch control facility can receive messages transmitted from SAC headquarters via the SLFCS. While the enormous transmitting towers are certainly vulnerable to attack, the Looking Glass is able to transmit low frequency messages with a long wire antenna that trails behind the aircraft in flight. Further, since the low frequency wave can penetrate the ground, the receiving antennae for LF communications at missile silos can be buried and therefore protected from nuclear attack.[2]

---

1 Lt.Col. Robert S.Burt, "Low Frequency Communications - The 487L System", (Signal, November 1967), p 24-5.

2 ibid.

In 1964, the existence of yet another, but highly classified Air Force communications system developed to provide survivable communications to the strategic forces was revealed. Known as the Emergency Rocket Communications System, or ERCS, it was apparently developed as a "last resort" SAC command and control system. If all other means of communicating with the SAC forces had been destroyed by an enemy attack, ERCS would supposedly allow one last message to be transmitted to those forces. The system itself comprises a rocket launch vehicle which would loft a communications package into a high ballistic trajectory. While in flight, the package would broadcast preprogrammed messages to the SAC forces on an ultra-high-frequency wavelength.[1] Presumably the message would contain orders to launch a particular option within the SIOP. However, considering the limited capabilities of ERCS, as well as its status as a "last resort" system, one can only assume that the message would entail a massive attack.

The Air Force is currently in the midst of a programme to develop a satellite communications system that would further enhance the survivability of its capability to communicate with its strategic forces. The system, known as the Air Force Satellite Communications System (AFSATCOM) would consist of special communications equipment carried on-board "host" satellites (placed in orbit for other reasons), in addition to numerous ground and air terminals. The system is being designed to provide for two-way communications between the forces and the command posts and would therefore, according to Schlesinger,

---

1 "Command and Control Reorientation to Handle Flexible Response Policy", (Missiles and Rockets, March 30 1964), p 84.

"...enable the forces to report back the data needed by the NCA National Command Authorities to maintain sure contact and to execute a variety of options".[1] The first launching of the AFSATCOM equipment into orbit is scheduled for 1975.

The Air Force is also considering the possibility of developing an even more advanced satellite communications system. Now referred to as AFSATCOM II, this system would incorporate certain design features developed specifically to reduce the vulnerability of both the ground and airborne terminals, as well as the satellites, to the effects of EMP or jamming.[2] One such feature might be the use of nuclear instead of solar power on board the satellites, since the use of solar panels is considered to make satellites particularly vulnerable to EMP. Two satellites to test the feasibility of radioisotope power generation (Les 8 and LES 9) are scheduled for launch in late 1975.[3]

Retargetting Flexibility: The Command Data Buffer System

In the above discussion of the relationship between the current SAC command and control system (SACCS) and strategic nuclear flexibility, it was suggested that the ability of the primary SAC command post to monitor the status of the SAC bombers and missiles in near "real time" which was afforded by SACCS'

---

1 Department of Defense, Annual Report, FY 1976, p II-52.

2 ibid.

3 Edgar Ulsamer, "C³: Key to Flexible Deterrence", (Air Force Magazine, July 1974), p 46.

information processing capabilities would be an integral element in providing for a capability to actually retarget the strategic forces during the course of a nuclear war. Such a capability would in effect represent the maximum degree of force control conceivable. Assuming that the SACCS computers could be programmed to determine which forces were in fact available to attack particular targets, this degree of flexibility would be further dependent on the survivability of a command post with the same automatic data processing capability which SACCS provides to the primary SAC Headquarters command post and a means to communicate with the strategic forces, as well as the extent to which the strategic forces themselves would be amenable to remote and rapid retargetting.

A significant degree of targetting flexibility has in fact already been designed into the current SAC forces. The B-52 bombers reportedly carry on-board several alternate target lists, each comprising different kinds and types of targets - e.g., cities, industrial centres, military installations, silo fields, etc. In the event that the bombers were ordered to attack an enemy, the bomber crews would be ordered to pattern their attacks according to the instructions relating to a particular target list. The decision concerning which target list to implement would presumably reflect the strategic option which had been selected by the President - e.g. attacks against military installations, massive counter-value strikes, and so on.[1] The targets which would be attacked by the missile force are

1 Frylund, op.cit., p. 15.

in fact pre-programmed in the guidance computer in each missile warhead. These guidance computers are reportedly pre-programmed to attack several alternate targets. The actual target (or targets, in the case of MIRVed missiles) a particular missile attack would be selected by the crew in the launch control centre according to the instructions that it would receive from higher authority.[1]

Whether more targetting flexibility than already exists in the forces themselves would be necessary for the degree of overall strategic flexibility suggested by Schlesinger's emphasis on increasing the number of options available in the event of a war is a difficult subject to broach because of the highly classified nature of the SIOP and its contents. Some defense analysts have in fact argued that the number of missiles and warheads that the U.S. would have available for use in the event of a nuclear war and the ultimately finite number of targets that the U.S. would ever consider attacking obviates any requirement for more targetting flexibility.[2]

The Defense Department's position on the flexibility with which the SAC missile force can be retargetted has apparently undergone a significant shift in emphasis in response to the recently renewed emphasis on strategic flexibility. For example, in 1969 the Air Force submitted a proposal to the JCS suggesting the development of an automated control system which would allow for the remote and rapid reprogramming of the target information

---

1 Interviews No. 6 and 18.

2 I am indebted to Interviews No. 14 and 27 for bringing this argument to my attention.

stored in the Minuteman warhead computers. Without such a system, the task of changing the pre-programmed target information was normally a complicated and time-consuming process. A new targetting tape had to be produced at SAC Headquarters in Omaha and then flown to the various Minuteman bases scattered throughout the United States. Then a "retargetting team" had to physically enter each missile silo in order to effect the necessary changes in the missiles on-board computer.[1] Thus, in the event of an actual nuclear war, the difficulties associated with the retargetting process would make it virtually impossible to change the targetting information already programmed in the missiles.

Some Air Force officials argued that a more rapid, or "real time" reprogramming capability would enhance both the effectiveness and the flexibility with which the Minuteman force could be employed. With such a capability the missiles could be re-targetted to attack targets not included in any SIOP option, or to substitute for missiles which had been assigned to important targets but had failed to launch or did not successfully reach their targets. In 1969 the JCS rejected the option of developing a system for re-programming the Minuteman in case of failure because, according to testimony of Dr. Wolfgang Panofsky, the system was considered too cumbersome and susceptible to deliberate interference by the enemy.[2] Another explanation that has been provided for the rejection of the Air Force proposal was that a re-programming capability was considered unnecessary for the employment of the Minuteman force

---

1 Edgar Ulsamer, "MX: The Missile System for the Year 2000", (Air Force Magazine, March 1973), p 44.

2 U.S. Congress, The Congressional Record-Senate, February 17, 1972, p S1940.

in accordance with the existing doctrine, with its emphasis on the assured destruction capability.[1]

Later that same year, however, the Air Force submitted a proposal for a similar remote re-programming system. This time the programme was justified in somewhat different terms. As described above, without an automatic and remote re-programming capability, the re-targetting of a _Minuteman_ missile was a complicated and time-consuming process. Despite the costs and difficulties involved in this operation, a considerable portion of the entire missile force was routinely re-targetted every six months to implement revisions in the SIOP.[2] The Air Force thus argued that the expense and difficulty of this routine task could be significantly reduced if the _Minuteman_ could in fact be remotely re-programmed. On the basis of this justification the JCS approved the Air Force plan for a system which would allow for the rapid and remote re-programming of the _Minuteman_ force. The following year, 1970, the Air Force proposal was approved by the Defense Department as the so-called Command Data Buffer System.[3]

The Command Data Buffer System reportedly allows for the remote, automatic re-targetting of up to 50 _Minuteman III_ missiles from a single launch control centre. The system has been installed and tested in one squadron of _Minuteman III_ launch control centres as part of an overall "silo upgrade

---

1 "Treatment of Operations Research Questions in the 1969 Safeguard Debate", (_Operations Research_, September 1971) p 1203.

2 Ulsamer, _op.cit._, p 44.

3 Interviews No 11 and 18.

programme."[1]

Although the Command Data Buffer system was originally justified as a means of facilitating the routine retargetting of the *Minuteman* force, as with many other command and control systems described in this study, it soon came to be identified primarily in terms of its importance to the issue of strategic flexibility. For example, in 1973 one Air Force general was quoted as explaining that the Command Buffer system "... implies, at least potentially, the capability to reconstitute the force (after a nuclear strike) and the ability to retarget with the aid of an attack assessment system. Simply stated, this means we will be able to survey what's left of our own forces and to retarget and reassign with the speed of light."[2] Likewise, in discussing the system in the FY 1975 annual report, Schlesinger referred only to its contribution to enhancing the flexibility of the employment of the *Minuteman* force.[3]

Naval Strategic Command and Control Systems

This study's examination of strategic command and control systems has thus far been limited to those systems which have been developed by the Air Force for the Strategic Air Command. The bombers and missiles of SAC constitute only two elements of the so-called "Triad" of U.S. strategic nuclear weapons. The third component consists of the Navy's 41 nuclear powered

---

1 Department of Defense, *Annual Review, FY 1975*, p 55.

2 Ulsamer, *op.cit.*, p 44.

3 Department of Defense, *op.cit.*, p 55.

submarines armed with Polaris A-3 and Poseidon sea-launched ballistic missiles. Unlike the Air Force, the Navy has not accorded very much publicity to its strategic command and control capabilities regarding the so-called Fleet Ballistic Missiles (FBMs), although it is apparently more willing to discuss its various tactical command and control systems. Likewise very little information is available in the "trade press" relating to naval strategic command and control. Even in the Defense Department annual report, FBM command and control is not mentioned until the fiscal year 1968 edition, although command and control for SAC had been discussed as early as the FY 1960 report.

The apparent paucity of information regarding naval strategic command and control could be attributed to a number of factors. First, the Navy could in fact be a good deal more secretive about its programmes and the lack of information might reflect a conscious and deliberate Navy policy not to release the details of such systems. However, given the annual requirement for the services to justify their respective request for defense funds, including those involved with command and control developments, it seems reasonable that the existence of any major command and control systems would at least be alluded to in the Defense Department report to Congress.

A more plausible explanation for the Navy's apparent lack of emphasis on strategic command and control, until recently anyway, is derived from the priority which the Navy has traditionally assigned to its surface fleet and their requirements. Senator Henry Jackson, an early Congressional advocate of the

Polaris submarine system has related that the Navy was rather reluctant to accept the FBM role in the first place.[1] To the extent that the Navy has concerned itself with strategic nuclear issues, it has generally leaned in favour of the assured destruction role which has usually been associated with the FBMs.

The overall attitude of the Navy toward its Polaris submarines has correspondingly manifested itself in the Navy's attitude toward the command and control of those forces. Harvey Sapolsky points out in The Polaris System Development that command and control had been recognized as the potential "Achilles heel" of the nuclear submarine programme as early as 1957. A debate soon ensued within the Navy regarding the kind of FBM command and control system that should be developed. The debate was apparently integrally related to the conception of the strategic role that the submarines were to perform. If, for example, the Polaris submarines were to be used only in conjunction with the massive retaliation doctrine, then the FBM command and control system would not need to be any more complex than a system which could get-out the "go-code", "whether of not it got through to all submarines in one hour or ten."[2] If, however, the FBMs were to be used to perform more selective and limited nuclear strategic options, then a more complex (and expensive) command and control system would be required.

Furthermore, the technical problems associated with communications with submarines on station are formidable. The submarines are also forced to operate under the water's surface in

---

1 Armacost, op.cit., pp 65-6.

2 Harvey Sapolsky, The Polaris System Development: Bureaucratic and Programmatic Success in Government, (Cambridge, Massachusetts: Harvard University Press, 1972), p 239.

order to avoid detection by the enemy's anti-submarine warfare (ASW) forces. Thus, the lower frequency ranges offer about the only effective means of communicating with the submarines, since they are both long range and capable of penetrating the water's surface.[1] However, as was discussed earlier, lower frequency communications require rather large, and therefore highly vulnerable transmission antennae. In addition, the amount of information which can be communicated via low frequency (the data rate) is relatively low. Therefore, reliance on low frequency communication imposes a significant restriction on the amount and complexity of the information which can be transmitted to the submarines at any given time. When the inherent difficulties of communicating with the submarines is considered along with the limitations of the FBMs themselves as far as use for highly selective and discriminating options are concerned (the difficulties of fixing the position of the submarine at any given time reportedly magnifies the inaccuracies of its missiles), Navy doctrine has not surprisingly tended to emphasize the assured destruction role of the FBM force. Likewise, the actual Navy command and control development programmes (as opposed to communications research) have concentrated on the requirements of transmitting basic execution orders.

The current Navy FBM command and control system is comprised of very-low-frequency (VLF) transmitter sites at seven known locations.[2] Navy officials have noted that these sites are

---

1 Edgar Ulsamer, "Communications Must Not Limit National Strategy", (Air Force Magazine, July 1973), p 43.

2 North West Cape, Australia; Jim Creek, Washington; Balboa, California; Annapolis, Maryland; Cutter, Maine; Hawaii; and, the United Kingdom. Armed Forces Management, July 1970, p 41.

highly vulnerable to a direct attack. This situation has led some Defense Department command and control officials to argue that the FBM command and control system is the "weakest link" in the total U.S. strategic command and control structure.[1] At the same time, however, Navy officials have expressed some confidence that the redundancy of the VLF sites would allow execution orders to be broadcast from the Naval command and control centre in Norfolk, Virginia, to the submarines via a surviving VLF site.[2]

The Navy has also explored the possibilities of developing two further strategic command and control systems as either supplements or replacements for the VLF transmitter system. The first of these follow-on programmes is known as Tacomo. Tacomo first came into operation in 1969. The system consists of twelve modified Lockheed C-130 Hercules aircraft which in effect act as airborne VLF transmitters.[3] The Tacomo aircraft, as well as the ground-based VLF transmitters, reportedly maintain continuous contact with the National Military Command Center in the Pentagon, and the SAC command post.[4]

---

1 Ulsamer, op.cit., p 43.

2 "Navy: A Theory of Evolution", (Armed Forces Management, July 1970), p 41; "Navy Emphasizes Swing Toward Strategic Command and Control", (Armed Forces Management, July 1969), p 62; and Edgar Ulsamer, "Nuclear-Proof Flying Command Post," op.cit., p 64.

3 Armed Forces Management, July 1969, p 63.

4 Department of Defense, op.cit., p 74.

The Navy has also been studying the feasibility of developing a command and control system which would employ extremely low frequency (ELF) communications. An ELF system would reportedly offer the advantages of being relatively immune from atmospheric as well as man-made interference and allowing the submarines to operate at even greater depths than is possible with the present VLF system while still being able to receive communications.[1] The ELF system, known as Sanguine, has not yet progressed beyond the experimental stage. Experimental sites, including a 14 mile-long, cross-shaped transmitter antenna constructed in Wisconsin, have engendered considerable opposition from local inhabitants. They reportedly fear that the systems will have an adverse impact on the local environment, as well as making their area an obvious target for an enemy attack. On the basis of various studies conducted by Hazelton Laboratory (a TRW subsidiary), Bell Telephone, and RCA, the Defense Department has argued that an ELF system would not pose environmental problems.[2] In early 1975, the Defense Department reiterated its strong recommendations that testing and development of the Sanguine system be continued, citing the need for a more survivable communicating link with the Navy's FBM submarines.[3]

---

1 ibid., pp. 77-8. Also, Armed Forces Management, July 1970 p 42.

2 Armed Forces Management, July 1969, p 63.

3 Department of Defense, Annual Report, FY 1976, pp II 53-4.

CHAPTER FIVE

Tying the Systems Together: The NMCS and WWMCCS

The previous chapters have discussed the various strategic command and control systems which have been developed by the Air Force and the Navy to make decisions regarding the use of their respective strategic nuclear forces and to transmit these decisions to the forces. While the services are responsible for the actual implementation of strategic options the authority to order the use of U.S. nuclear weapons in vested solely in the President. The following chapter describes the efforts which have been made to provide the President with a "strategic command and control system" to provide him with the information which he might require in order to make decisions regarding the use of the strategic forces and to have those decisions relayed to the forces. The capabilities which such a system would afford the President is particularly relevant to the degree of flexibility with which the U.S. strategic nuclear forces could be employed in the event of a nuclear war.

The Problem of System Incompatability

The strategic offensive and defensive command and control systems which were discussed in the previous two chapters were designed and developed almost exclusively by individual services, and in some cases, by individual commands - such as SAC. Despite the independent development of such command and control

systems, the fact remains, that no one service has been delegated exclusive responsibility for strategic nuclear operations in the event of a nuclear war. Both SAC and Navy forces comprise the so-called "triad" of strategic nuclear forces. Even the Army has shared the strategic air defense role with the Air Force with its batteries of surface-to-air missiles. As Michael Armacost suggests in The Politics of Weapons Innovation, the fragmentation of the strategic nuclear "mission" among the various services resulted as much from intense political competition for a "piece of the strategic action", as from the assumption of more traditional roles.[1]

Whatever its causes, the extent to which various strategic roles have been delegated among the three services is reflected in the diversity of the systems which have been developed to implement them. The use of different research and development facilities, industrial contractors, hardware, and computer languages and procedures (commonly referred to as "software") has in most cases precluded the common use of the systems, even though the activities of two or more services may be closely related in certain areas. The situation in which differences in hardware and software prevent common or joint use of different systems to perform a particular function is generally referred to as "system incompatability".

The incompatability problem is particularly relevant to the command and control systems of the various services. For example, a former NORAD commander has related that at one time in the 1950s, a particular SAGE command centre had been colocated with

1 Armacost, op.cit.

an Army air defense battery. However, the design of the respective command and control systems of the two units made it impossible for them to communicate with one another about their common problem - namely, approaching enemy bombers.[1] Command and control specialists have argued that the lack of compatability among the various command and control systems, exemplified by the above case, in effect has resulted in a wasteful duplication of effort, and, at the same time, has prevented the internetting of the various systems to enhance their overall survivability through redundancy.[2]

The lack of integration due to system incompatability in fact has broader implications than those regarding the efficient conduct of military operations. As was discussed in Chapter Two, the destructive potential of nuclear weapons and the political ramifications of their use, had led most command and control specialists as well as civilian Defense Department officials to conclude that the use of nuclear weapons should be strictly controlled and highly centralized. The focal point of this centralized control has been the President. The ability to control operations, requires that the President, as well as any other military commander, have at his disposal the means to readily acquire the information needed to make decisions and select options, as well as the means to insure that his decisions are carried out.

---

1 Interview No. 1.

2 For example, "Dr. Fubini Stresses DDR&E's Desire for System Compatability", (Data, February 1965), pp 7-13.

The Partridge Committee

Concern with the lack of compatability among the various service command and control systems in addition to efforts to insure that the President could maintain control of a given military situation came to a single focus in the early days of the new Kennedy administration. McNamara's interest in command and control, both as a means of implementing a selective response strategy and maintaining civilian control over the use of nuclear weapons, has already been discussed. Several of his "trombones" correspondingly addressed themselves directly to the issue of command and control. Initially both the JCS and DDR&E were tasked to produce a study concerning the development of a national command and control system that would be both survivable and under the direction of the President. Their efforts resulted in two separate reports, and an *ad hoc* committee, under the direction of Air Force Brig.Gen. L.G. McCollom, was formed to resolve the points of difference between them.[1] In the process of coordinating its work with several Defense Department agencies, the McCollom committee gave rise to even more reports than the original two. The task of consolidating the now obvious variety of views on command and control within the Defense Department was subsequently given to a newly formed command and control study group, under the chairmanship of recently retired Air Force General Earl E.Partridge.[2] General

1 *Aviation Week and Space Technology*, September 11, 1961, p 21.

2 *Aviation Week and Space Technology*, September 18,1961, p 25.

Partridge had at one time been the commander of NORAD, where he had distinguished himself as a strong advocate of increasing the degree of compatability between the command and control systems and procedures of NORAD and SAC.[1]

The Partridge Committee, as the study group became known, first met in September 1961. The committee was given the task of examining the entire spectrum of command and control issues, apparently without instructions to consider specific nuclear strategies.[2] The resultant report remains classified, however, many of its major points have become known. Perhaps, the most important development to emerge form the Partridge Committee was the creation of the so-called National Military Command System in June 1962.[3]

The NMCS was specifically designed to provide the "national command authorities" - then defined as the President, the Secretary of Defense and the Joint Chiefs of Staff[4] - with a command and control system which could allow for the effective control of important military operations by the President. The NMCS thus bore the stamp of both President Kennedy and Secretary McNamara's concern about the extent to which the President could control or manage the actions of the military in any given crisis situation. Both men reportedly feared that the singular actions

---

1 Interviews No 1, 2, and 24.

2 ibid.

3 James Baar, "New U.S. Command System Coming", (Missiles and Rockets, December 4, 1961) p 12.

4 "Command and Control to Handle Flexible Response", (Missiles and Rockets, March 30, 1964) p 80.

of even the lowest echelon unit, if not carefully controlled from Washington, could set in motion an uncontrollable escalation to "all-out war".[1] While the purposes of the NMCS were particularly relevant to the control of tactical operations - as the Cuban Missile crisis and the Vietnam conflict would later illustrate - the NMCS was also geared toward providing extensive centralized control of the strategic nuclear forces. One Air Force general responsible for the technical design of the NMCS stated in 1964, "...In the case of our major weapons systems, (i.e., strategic forces) we are designing the capability to go from the highest command levels right down to the actual weapons sites if the need should arise."[2]

The National Military Command System

Plans for the NMCS did not entail the construction of an entirely new set of hardware, as had been the case with SACCS, for example. Rather, the NMCS was to effect the partial integration of the various tactical and strategic command and control systems by tying several of their respective functions together under a single heading - namely, the NMCS. The diverse service systems were to be linked together at the "top", with the NMCS as the capping system. The most immediate and obvious difficulty to be surmounted in effecting the integration suggested by the

---

1 Interviews No. 12, 22 and 23.

2 Maj. Gen. John B.Bestic, "National Military Command System: Decision Instrument for the Chief Executive", (Data, March 1964), p 7.

creation of the NMCS would prove to be the degree of incompatability among the major systems operated by the various services.

While the NMCS ostensibly consisted of elements from virtually all military command and control systems, several facilities and systems were constructed exclusively for its own purposes. Perhaps the most important of these is the National Military Command Center (NMCC). The NMCC is physically located within the Pentagon. It is reportedly able to receive information directly from the various early warning systems, as well as the Nuclear Detection and Reporting System (NUDETS). In addition, the NMCC is linked to the Pentagon "war rooms" of the various services, as well as to the command and control systems of the unified and specified commands - including the NORAD 425L system and SACCS.[1] Thus, the NMCC, theoretically at least, has direct access to the same information and control capabilities which the various command and control systems make available to the NORAD and SAC commanders, including early warning, attack assessment, monitoring of the forces, etc. The NMCC also has various links with the State Department, the CIA, the National Security Agency, and the White House Situation Room - whose "command and control equipment" was described in 1963 as consisting of telephones, maps and clipboards.[2] In addition, the terminal for the Moscow "Hot Line", or "Molink" is located in the NMCC as per agreement with the Soviet Union.[3] The NMCC was

---

1 J.H.Wagner, "NMCS: The Command Backup to Counterforce", (Armed Forces Management, July 1963), p 24.

2 ibid.

3 "Effectiveness, Responsiveness of National Command System Vital to U.S. Security", (Armed Forces Management, July 1966), p 44.

originally located in the Pentagon's Joint War Room, but in 1965 it was moved to a larger facility in the Pentagon to accomodate the addition of more sophisticated communications, data processing equipment and displays.[1]

The National Military Command Center is located in a "soft" site - that is, it is quite vulnerable to nuclear attack. The survivability of the NMCC as well as the entire NMCS structure has been a major concern of defense command and control specialists since the NMCC is the President's primary link to the strategic forces. For example, Esterly Page, who at one time headed the DDR&E role in developing technical support systems for the NMCS stated in 1963 that,

> "The object of the NMCS is to provide support to our national command authorities, or their successors, for the direction of the U.S. military forces under all conditions of peace and war. If it were necessary to describe a key element of the NMCS in one word that would be "survivability". Our goal is to insure the continuity of the national military command function under <u>any</u> and <u>all</u> conditions"[2]

Not surprisingly, all three concepts of insuring the survivability of a particular system - hardening, redundancy, and mobility - have been applied in the case of the NMCC.

An Alternate National Military Command Post (ANMCC) has been constructed in a hardened facility in the vicinity of Washington, D.C. This command centre would reportedly operate with less staff than the NMCC in an emergency, but with essentially the same computer facilities.[3] For several years, the Navy operated two

---

1 <u>ibid</u>.

2 Esterly C.Page, "The National Military Command System: A Director's View", (<u>Signal</u>, April 1963), p 7.

3 <u>Armed Forces Management</u>, July 1966, p 46.

National Emergency Command Posts Afloat for the NMCS on-board a converted cruiser and an aircraft carrier, the USS Northhampton and USS Wright, respectively.[1] The two sea-borne alternates for the NMCC were eventually retired as part of a defense austerity measure.[2] Finally, an alternate command facility has been provided on-board the so-called National Emergency Airborne Command Post (NEACP, which is usually pronounced "Kneecap"). Like the SAC Looking Glass, the NEACP employs a modified Boeing KC-135 tanker. Successive modifications of the NEACP have improved the communication and information and storage retrieval capabilities on-board, and, ostensibly the degree of command and control which can be exercised from it.[3] (The implications of this trend will be discussed more fully in the following pages).

The NMCC, or any of its alternates, has been defined as the focal point from which the President and his staff would be able to "...monitor operations, communicate with personnel, and if they wish, to issue direct orders to all levels of the entire NMCS hierarchy".[4] Just how the President and his staff would actually make use of the NMCC or any of its alternates in a crisis which might involve the use of the strategic nuclear forces has not been made clear because of the sensitivity of the

---

1 ibid., p 44

2 Michael Getler, "President's Personal Interest Is Key Ingredient for Success", (Armed Forces Management, July 1970), p.19.

3 Maj. Gen. John B.Bestic, "NMCS Affords U.S. Full Control and Flexible Response" (Data, January 1967), p 29.

4 J.S.Butz, "White House Command Post - 1966", (Air Force and Space Digest, April 1964), p 76.

subject. For example, while the JCS prepares certain "emergency action procedures" which relate to the operation of the NMCC during a nuclear crisis, the corresponding White House plans are rarely discussed between military and White House officials - probably to allay fears that the military might be capable of usurping the President's authority in a crisis if it knew the procedures the President would follow in such a situation.[1] Consequently, the military has predicated its command and control procedures on the assumption that the President, or his successors would somehow survive to implement the U.S. strategy.[2] It is known, that the capabilities of the NMCC, most significantly its links to the various strategic command and control systems, are available to the President through links to the White House. Presumably, if the Washington area were not under attack, the President could opt to monitor the situation from the White House. If the Washington area were in jeopardy, the President would most likely make use of one of the alternate command posts. The NEACP, for example, is stationed at nearby Andrews Air Force Base. President Nixon had reportedly had a "demonstration ride" on board it.[3] From the NEACP, the President would reportedly be able to maintain contact with the SAC and NORAD command posts as well as the SAC <u>Looking Glass</u> airborne command post, and through it, the SAC forces themselves.

---

1 Interviews No. 3 and 6.

2 <u>ibid</u>.

3 Getler, <u>op.cit</u>., p 19.

The World-Wide Military Command and Control System

In the late 1960s, several incidents occurred which led to a critical appraisal of the capabilities and structure of the entire national military command system - namely, the capture of the Pueblo, the downing of the EC-121 by North Korea, and the Israeli strafing of the Liberty. While these events primarily concerned the control of tactical operations, they had a twofold impact on the issue of strategic command and control. First, they raised questions regarding the degree of control which could in fact, be maintained over strategic operations given the apparent failure to adequately control lesser activities.[1] Second, they led in part to a thorough restructuring of the management of the process of command and control integration which had ostensibly begun with the creation of the NMCS in 1962.

This change was officially effected by the publication of a revised version of DOD Directive 5100.30 on December 2 1971.[2] The directive, entitled "Worldwide Command and Control System (WWMCCS)", outlined the manner in which the WWMCCS (usually pronounced "Wimmex") would in the future be developed. The WWMCCS concept had in fact been in existence since October 1962. It was originally intended as an instrument to integrate portions of all the command and control systems used by U.S. military

---

1 U.S. Congress, House of Representatives, Committee on the Armed Services, Inquiry into the Pueblo and EC-121 Plane Incident, 1969.

2 U.S.Department of Defense, "Worldwide Military Command and Control System (WWMCCS)", DoD Directive 5100.30, op.cit.

forces.[1] However, primary emphasis was subsequently placed on the development of the NMCS, which had been defined as a component of the broader WWMCCS. Furthermore, the process of integration on the scale envisioned by the WWMCCS directive of 1962 had for several years suffered from a lack of unified direction.

In many respects, the shift in emphasis from the NMCS to the WWMCCS manifest by Directive 5100.30 could be considered a semantic technicality, since the systems which fall under the purview of the NMCS include the vast majority of the WWMCCS related systems. Nevertheless, 5100.30 was also intended to accomplish major changes in the nature and management of national command and control. For example, in the June 1962 memorandum concerning the technical support for the NMCS, McNamara had in effect divided the responsibility of developing the NMCS among three separate agencies - DDR&E, the Defense Communications Agency, and the Joint Command and Control Requirements Group under the JCS. This triumverate arrangement apparently created a multitude of administrative difficulties. One military journal remarked that, "...the Washington, D.C. outfits responsible for building a national military command system amount to an organizational, procedural and management monstrosity."[2]

This arrangement persisted essentially intact until the reorganization of command and control responsibilities effected by 5100.30. The directive accordingly established a "WWMCCS Council" to provide policy guidance for the development and operation of the WWMCCS and to evaluate its overall performance.[3]

---

1 Missiles and Rockets, March 30, 1964, p 80.

2 C.W.Borklund, "How to Succeed in Spite of Yourself", (Armed Forces Management, July 1964), p 9.

3 U.S.Department of Defense, op.cit., p 8.

The Council consists of the Deputy Secretary of Defense, the Chairman of the Joint Chiefs of Staff, the Assistant Secretary of Defense (Intelligence), and the Assistant Secretary of Defense (Telecommunications). This latter position had been created by a related directive and marked the first time that a position at the assistant secretary level was to deal directly with command and control matters.[1] In January 1974, this position was changed to that of Director of Telecommunications and Command and Control (DTACCS).[2] The establishment of the WWMCCS Council in effect provided command and control development and integration process with a single "manager" within the Defense Department.

Another important change instituted by 5100.30 concerns the level at which command and control developments were to be defined. A 1963 Defense Department memorandum had accorded the commanders of the unified and specified commands responsibility for planning, developing and installing their own command and control systems.[3] This directive was predicated on the premise that the commanders who were to use the systems were perhaps the best judges of the kind of systems they required. As was demonstrated in Chapter Four, SAC often took the lead in specifying the command and control requirements and in initiating

---

1 U.S.Department of Defense, "Assistant Secretary of Defense (Telecommunications)", Department of Defense Directive 5135.1, January 11, 1972.

2 U.S.Department of Defense, "Director of Telecommunications and Command and Control", Department of Defense Directive 5135.1, January 17, 1974.

3 <u>Armed Forces Management</u>, July 1966, p 45.

their subsequent development programmes. However, without an effective manager at the Pentagon level, attempts to insure the compatability of the various systems being developed in order to integrate them into the NMCS was virtually a hopeless task. In describing just what 5100.30 would mean, the Deputy Secretary of Defense, David Packard, who was the major force behind the new directive stated,

> "We are making some changes which will, in effect, centralize and improve the management of WWMCCS, and more importantly that portion of WWMCCS which is called the National Military Command System...this then will be managed from the top rather than from the focal point of the commander."[1]

The directive correspondingly required that the "...command and control of all other DOD components be configured and operated for effective support of the NMCS as well as their specific missions".[2] At the same time, the directive also pointed out that the WWMCCS' primary responsibility was to support the NMCS and only secondarily to support the military services themselves.

A third, and from the perspective of this study, the most important change reflected in the directive concerns its definition of the national command authorities and its delineation of the "chain of command" from the President to the actual forces. Previously, the national command authority had been defined to include the President, the Secretary of Defense, and the Joint Chiefs of Staff.[3] Furthermore, the Joint Chiefs of

---

1 Quoted in Owens, _et al_., _op.cit_., p 34.

2 U.S.Department of Defense, "Worldwide Command and Control System (WWMCCS)," _op.cit_., p 3.

3 _Missiles and Rockets_, March 30, 1964, p 80.

Staff had been defined as constituting:

> "...the immediate military staff of the Secretary of Defense, serving in the chain of command that extends from the President to the Secretary of Defense, through the Joint Chiefs of Staff, to the commanders of the unified and specified commands." (My emphasis added).[1]

5100.30, however, deleted the Joint Chiefs of Staff from the definition of the national command authority. It left the delineation of the chain of command intact with one notable exception - namely, when the use of nuclear strategic forces are involved. The directive states that, "...The channel of communication for the execution of the Single Integration Operations Plan (SIOP) and other time sensitive operations shall be from the NCA through the Chairman of the Joint Chiefs of Staff to the executing commander."[2] In other words, in those operations involving the SIOP, the President would, in effect, bypass the service chiefs and the unified and specified command commanders (i,e, the SAC and NORAD commanders) and communicate directly with a bomber, missile, or submarine crew.

The implications of this change are considerable. The directive in effect gives expression, in theory at least, to the complete centralization of the control of military forces

---

1 U.S. Department of Defense, Brief on the Organization and Function, Secretary of Defense, Defense Staff Officers, Organization of the Joint Chiefs of Staff, Department of Defense Agencies, Joint Service Schools, April 1963, p 13, quoted in Smith and Johns, op.cit., p 384.

2 U.S. Department of Defense, "Worldwide Military Command and Control System (WWMCCS)",op.cit., p 2.

in the person of the President. In terms of command and control the directive implies a requirement for a system which would in fact allow the President to communicate directly with the "executing commanders". In terms of strategic flexibility, the directive suggests that if the President can communicate directly with the "executing commanders" then he could at the same time directly supervise the implementation of specific strategic nuclear options.

The Survivability Issue: Revisited

On the surface at least, the dominant attitude in the Defense Department in 1971 with respect to command and control was remarkably similar to the situation which had characterized McNamara's Pentagon in 1961. First, as with the Partridge Committee, the overall direction of command and control developments had been subject to a thorough review, resulting in a decision to revitalize and reorganize the efforts to construct an integrated and survivable command system which would be responsive to the President. Second, the renewed emphasis which was being placed on the issue of strategic nuclear flexibility in the Pentagon and elsewhere in the Executive led many command and control specialists to recommend programmes which they defined as being necessary for the flexible employment of the strategic forces.

However, the various command and control systems which have been discussed in the previous two chapters are considered capable, or at least potentially capable, of performing the functions which have been defined as necessary for the

implementation of a selective response strategy. The various early warning systems are reportedly capable of providing rapid and credible warning of missile attack against the United States. Furthermore, the early warning systems are also capable of providing some attack assessment information, and, in response to the renewed emphasis on strategic flexibility, efforts are currently underway to develop computer programs to correlate the output of these systems to provide even more precise information regarding the nature and character of an enemy attack. A variety of communications systems have been developed to insure that the decisions of the national command authorities would be transmitted to the strategic forces before, during and after a nuclear attack on the U.S. The information processing capabilities of the SAC Automated Command and Control System is reportedly capable of providing up to date information on the status of the SAC forces and their availability to perform particular attack options. Also, a system which would allow for the remote and "real time" reprogramming of <u>Minuteman III</u> missiles is currently being installed at <u>Minuteman</u> bases. In short, the strategic command and control systems which were built or designed prior to the 1970s ostensibly allow for a more flexible employment of the strategic forces than is implied by a spasm response strategy.

Command and control specialists argue, however, that the degree of flexibility with which the strategic forces could in fact be employed in the event of a nuclear war is contingent on the extent to which the capabilities afforded by the various command and control systems would be able to survive the effects of a nuclear attack. The survivability issue is by no means new to the field of command and control. As was discussed

earlier, survivability was a dominant concern in the early 1960s. Furthermore, various efforts were made to enhance the survivability of several command and control systems. However, many command and control specialists today contend that those systems which provide the capabilities which are the most critical for performing the functions associated with the implementation of a selective response strategy are in fact the most vulnerable. Specifically, the automatic data processing systems which, in the event of a war, would be used to process and display the information required for the selection of particular strategic options - including attack assessment, force and operational status information and retargetting - are located in ground-based command posts only and are therefore considered by many command and control specialists to be highly exposed to attack.

The Minimum Essential Emergency Communications System

The lengths to which the Defense Department was prepared to go in order to enhance the survivability of those systems which provided the capabilities specifically necessary for the implementation of a more flexible response strategy have undergone a significant change since 1969. For example, in that year, the Acting Deputy Director for Electronic and Information Systems in DDR&E, Herbert Benington, was quoted as remarking:

> "Do we want more than minimum survival? Is there a valid requirement for an overall battle management capability? ...If so...it would require that the battle staffs, electronic data and communications capabilities be survivable...In this

area our thinking is much less clear as to whether this type of battle management capability is either feasible or necessary We know that we must concentrate on the lower echelons, i.e. the Minuteman, Polaris, and B-52s. Also the methods of relaying the "go-word". But the higher you go the more complicated the task...It appears that it is better to keep retaliation pure and simple, and as unsophisticated as possible, until we become convinced that the sophisticated route is more advisable we are not ready for such advanced systems as, say, a large super airborne command post."[1]

Benington's remarks certainly did not reflect the entire range of views in the military "command and control community". The Air Force, for example, had been lobbying for an advanced airborne command post to replace the SAC Looking Glass as early as 1965.[2] The SAC Airborne Data Automation programme was in many respects conceived not only to test, but also to prove the feasibility of endowing an airborne command post with the same automatic information processing capabilities possessed by a ground-based command post. It is important to note, however, that at the time Benington made the above remarks, DDR&E still had the responsibility for establishing the technical support requirements for the NMCS. Thus, at least in 1969, the direction of command and control efforts would seem to have been officially limited to guaranteeing the ability for "pure and simple retaliation".

This attitude manifested itself most clearly in the emphasis which was accorded the so-called Minimum Essential Emergency Communications Network (MEECN), which publically surfaced in 1969. MEECN has been officially defined as "...a survivable

---

1 Quoted Armed Forces Management, July 1969, pp 41-2.

2 Interview No. 6.

communications network for passing on the execution orders to the nuclear forces assigned to the SIOP".[1] The development concept which governs the construction of the MEECN envisions the integration of three existing systems to achieve this stated purpose - namely, the Navy VLF/LF system, the Air Force VLF/LF Soecial Purpose Communications System, and the Emergency Rocket Communications System (ERCS).[2] By "internetting" these three separate systems - a process which, incidently, emphasizes the importance of system compatability - its designers propose that in the event that every other means of communicating with the strategic forces were somehow destroyed, that the execution orders would somehow find their way to those forces along a surviving component of the MEECN.[3]

The very nature of the systems which comprise the MEECN confirm the extent to which the emphasis in 1969 was placed on insuring the survivability of the means of simply relaying the "go-code". While the low frequency and very low frequency communications are perhaps the most survivable in a "nuclear environment" they are perhaps the least suited for the rapid transmission of the complex data required in the implementation of a selective response strategy. The ERCS, as described before, is simply a "last gasp" system. Apparently then, MEECN was intended to insure that even if an enemy deliberately attempted

---

1 Statement of Dr.John S.Foster, Jr., Director Defense Research Engineering to the House Armed Services Committee, quoted in Armed Forces Management, July 1969, p 42.

2 Getler, op.cit., p 21.

3 Armed Forces Management, July 1969, p 40.

to destroy the U.S. command and control system,the U.S. would always be able to launch a retaliatory strike of some kind. In the words of one Defense Department command and control specialist, MEECN's purpose is to provide "one message one time to the forces that still exist".[1] Thus, while MEECN may reflect an effort to preserve the credibility of the U.S. deterrent by ruling out the possibility that the U.S. command and control system could be "neutralized" by a first-strike, the system is geared more toward keeping retaliation pure and simple than insuring the capability for a flexible response.

The Advanced Airborne Command Post

While the prospects for any major efforts to enhance the survivability of those systems which provided capabilities which were defined as necessary for implementing a selective response were apparently largely discounted in 1969, it was obvious by 1972 that the official position had changed. Since that year the Air Force and the Defense Department have actively pursued the development of several programmes which are justified primarily in terms of enhancing the survivability of those systems which are considered essential for a flexible nuclear response. Perhaps the most important, or at least the most dramatic in terms of its size and scope, of these programmes is the development of the advanced airborne command post (AABNCP) to replace the current National Emergency Airborne Command Post (NEACP) and the SAC Looking Glass aircraft.

---

1 Interview No 6.

Command and control specialists have long argued that placing a system on an "airborne platform" is the most effective way to insure the survivability of that system.[1] As mentioned above, the capabilities that are considered essential for a selective response strategy - attack assessment, force control, etc. - require a considerable amount of automatic data processing equipment. This equipment is available in the ground-based command posts of SAC, NORAD, and the NMCC. However, placing the same equipment on an aircraft is practically ruled out because of the space and weight limitations involved. Successive modifications of the Looking Glass and the NEACP had improved their respective communications and data processing capabilities. However, the automatic data processing capability currently available on-board these aircraft apparently does not begin to approach the capability which would be needed to correlate large amounts of information required for attack and damage assessment, rapid re-targetting, etc.

Command and control specialists suggest, however, that the recent innovations in the construction of automatic data processing hardware - particularly the reductions in size and weight which are made possible with the use of minaturized components and circuitry - have made it possible to provide an airborne command post with roughly the same computer capabilities as possessed by the ground-based command posts.[2] Nevertheless, the

---

1 General Paschall, for example, has written quite unequivocably "An airborne command post is our most survivable command center". Maj. Gen. Lee M.Paschall, "Command and Control Why the Air Force's New Systems Are Revolutionary", op.cit. p 62.

2 Edgar Ulsamer, "Nuclear-Proof Flying Command Post", (Air Force Magazine, January 1973), p 66.

installation of an analogous data processing equipment on an aircraft, even considering the latest improvements in equipment design, would still require a larger aircraft than is currently employed by Looking Glass and the NEACP to accomodate it as well as the staff that would be required to operate it.[1]

The technological possibilities of improving the information processing capabilities of an airborne command post have, significantly, coincided with the renewed emphasis on developing the capabilities for flexible strategic response suggested by Nixon's and Schlesinger's remarks. The result has been a Defense Department decision to in fact proceed with the development and deployment of an advanced airborne command post that would incorporate a sophisticated information processing capability. The relationship between the advanced airborne command post and the issue of strategic flexibility is clearly evident in Schlesinger's remarks in the FY 1975 Defense Department review:

> "...If the NCA is to be in a position to exercise a wide range of nuclear attack response options, including some which may not have been preplanned, the data required aboard the aircraft (command post) would be quite extensive. In the case of the NEACP it would probably include status of forces and damage assessment for both sides...status of allied and other forces, and so forth. The SAC airborne command post might require even more detailed data, e.g. location and status of spare engines, reload weapons, fuel supplies, missile spare parts, maintenance capabilities."[2]

The Defense Department first received approval to proceed with the development of the AABNCP in the Fall of 1972.[3] The

---

1 ibid.

2 Department of Defense, Annual Report, FY 1975, p 76.

3 Ulsamer, op.cit. p 64.

programme itself is actually under the direction of the Air Force. Current plans envision equipping seven Boeing 747 Jumbo Jets as command posts in three phases. The first phase would involve fitting two 747s (designated E-4 for this purpose) with the existing equipment of the NEACP, to serve as an interim AABNCP. A third E-4 would be used as a test bed for the new equipment to be included in the finished product. Once this aircraft has been fully tested, the Air Force then plans to construct three more E-4s, complete with the new equipment, to replace the interim NEACP aircraft. In the final phase, the interim NEACP would be retro-fitted with the new equipment and turned over to SAC to replace the current Looking Glass. A seventh E-4 would be built to serve as a replacement for any of the six primary airborne command posts.[1]

The new E-4's would reportedly represent a significant improvement over the present airborne command post in more areas than just automatic data processing capability. The new aircraft would have a longer endurance than either the NEACP or the Looking Glass. Furthermore, it would also allow for an increase in the size of the battle staffs on the command posts, perhaps up to as much as a 100.[2] In the area of automatic data processing capabilities, Defense Department officials admit that no final decision has been made concerning the kinds and amount of information which the E-4 would require to perform its function. The indecision on this point results from perhaps one of the most perplexing problems confronting command and control specialists today - namely, determining precisely what

---

1 Department of Defense, op.cit., pp 76-7

2 Ulsamer, op.cit., p 65.

items of information would be required or even wanted by the President in deciding the appropriate option to exercise in the event of a nuclear war.[1] Plans have been made to provide the E-4's with a direct link to the WWMCCS computers which would allow for an automatic update of the computer data base on-board the aircraft. In addition, the refinements provided in Phase II and Phase III would reportedly endow the aircraft with the capability to receive data directly from the early warning satellite system. Like the current Looking Glass and NEACP the advanced airborne command post would also be able to communicate directly with the strategic forces with both high and low frequency capabilities. In addition, plans have been made to provide the E-4 with the capability to communicate via the Air Force satellite Communications system which is currently in the development stage.[2]

The advanced airborne command post represents the most recent and perhaps the most technically ambitious of the command and control systems which have been considered in the context of this study. Its development has been made possible by recent innovations in the minaturization of computer components, as well as the construction of aircraft the size of the Boeing 747. However, of all the systems which have been discussed above, the advanced airborne command post is perhaps the only system which

---

1 Paschall, op.cit., p 61-2. Also, Department of Defense, op.cit., p 76.

2 ibid.

has been justified solely in terms of the requirements of implementing a selective response strategy. In the words of one Defense Department command and control official, the advanced airborne command post "...meets about all of our objectives for support of a flexible response strategy...The advanced airborne command post, coupled with survivable communications is the main link between our objectives for support of a flexible response strategy...The advanced airborne command post, coupled with survivable communications is the main link between our policies and our forces." [1]

Having thus discussed the most important strategic command and control systems that have been developed in the past twenty-five years, several conclusions can now be drawn concerning the relationship between command and control developments and considerations of strategic nuclear doctrine.

---

1 Interview No. 6.

CONCLUSIONS

An examination of the present generation of U.S. strategic command and control systems reveals that they do in fact possess many of the capabilities which have been specifically associated with the implementation of a highly flexible, selective response strategy. Furthermore, current efforts on the part of the Air Force, the Navy and the Defense Department indicate that considerable emphasis is now being placed on enhancing the existing systems' capabilities to perform such functions as "real-time" attack assessment and retargetting of the strategic forces. As noted in the Introduction, one objective of this study has been to determine the extent to which the design and development of U.S. strategic command and control systems have been determined by conscious and deliberate considerations of the various technical requirements for alternate general war strategies. What then has been the relationship between command and control development and strategic nuclear doctrine?

As Morton Halperin and Graham Allison have pointed out in their respective works on the impact of bureaucratic politics on weapons systems development, an analysis of the reasons "why" any given system has been developed and deployed must take into account the fact that several government organizations and officials are usually involved in the decision-making relevant to that system. The various actors in this process will have varying reasons and interests for advancing a particular system, as well as varying levels of influence in determining the actual outcome of a particular development programme. The final product

of any development programme can, therefore, rarely be explained in terms of a single rationale for its existence, since each outcome is the result of an involved and often complex interaction of bureaucratic interests and bargaining.[1] Although this study has concentrated on the strategic implications and technological dimensions of the development of the U.S. strategic command and control systems, the nature of this element of varying bureaucratic interests has in fact been illustrated. For example, it was noted that the Air Force was concerned about improving the survivability of its command and control systems in the early 1960s in order to insure its ability to perform its strategic bombing "mission". The Secretary of Defense, on the other hand, seems to have been interested in command and control survivability primarily because of its implications for the maintenance of Presidential control over the conduct of military operations in a nuclear crisis.

Even after acknowledging the existence of certain bureaucratic political factors which could and have interjected themselves into the development of the current strategic command and control systems, one is still struck with the fact that a single or dominant rationale (official or otherwise) for proceding with the design and development of each system can generally be

1 Morton Halperin, Bureaucratic Politics and Foreign Policy, (Washington, D.C.: The Brookings Institution, 1974), and Graham T.Allison, "Questions About the Arms Race: Who's Racing Whom? A Bureaucratic Perspective", in Robert L. Pfaltzgraff, Jr. (ed.), Contrasting Approaches to Strategic Arms Control, (Lexington: D.C.Heath and Company, 1974).

clearly identified. Furthermore, this rationale was usually accepted by all concerned with the programme. This is perhaps largely due to the fact that the development of these systems was largely conducted by the Air Force, with surprisingly little interference or even supervision from outside agencies.

Significantly, the Air Force's interest in strategic command and control systems development during the 1960s appears to have derived primarily from internally generated concerns about its ability to effectively employ its strategic forces, particularly in a second strike context. The issue of strategic flexibility was not a significant factor in determining the nature and direction of command and control developments. For example, the early warning systems were constructed to provide sufficient tactical warning of an enemy attack for SAC to take appropriate measures to protect the vulnerable elements of its forces. The initial decision to proceed with development of the SAC Automated Command and Control System was made by the Air Force well before strategic flexibility had become an issue in the Pentagon and was determined by a desire to improve the efficiency of its existing means for monitoring and alerting the SAC forces. Likewise, both the Air Force and the Navy concentrated on enhancing the survivability of their systems for transmitting the "go-code". The Emergency Rocket Communications System, the Airborne Launch Control System, as well as the Navy's <u>Tacamo</u> and the Defense Department's MEECN programmes, were all directed toward insuring that the U.S. strategic forces would be able to make some sort of response to an enemy attack. The emphasis in command and control development during the 1960s was thus on insuring the means to retaliate and not on strategic flexibility.

This is not to conclude, however, that the requirements for strategic nuclear flexibility did not constitute an issue of some concern to various members of the civilian and military command and control "community" during the 1960s. The "McNamara strategy" had after all drawn considerable attention and study to the arguments in favour of increasing the number of strategic options available to the President in the event of a nuclear war, as well as the types of command and control systems that this would necessitate. Even after McNamara's own enthusiasm for the selective response doctrine had waned in 1963 certain Air Force officials continued to advance the desirability of strategic flexibility as justification for various command and control systems - for instance, the advanced SAC airborne command post and Command Data Buffer system. However their arguments had little impact at the time.

Whatever the actual intentions and justifications of the Air Force for the development of particular command and control systems, the technology which was employed in their construction nevertheless endowed them with many of the technical capabilities specifically associated with the implementation of a flexible response nuclear strategy. In a sense, the scientists and technologists had designed more capabilities into the systems than were perhaps strictly necessary for the literal performance of their stated functions. Thus, the early warning systems, particularly the early warning satellites, are inherently capable of providing certain types of attack assessment information, and with the application of automated information processing techniques, may be capable of providing even more precise attack

assessment information than is now possible. The automatic data processing capabilities of the SACCS could reportedly be employed to match actual SAC operations with the particular war plans being implemented and to subsequently retarget the necessary forces to compensate for deviations from the war plans caused by launch failures or the destruction of the U.S. forces. As was noted above, these two systems were originally designed and developed to perform somewhat different functions. However, because of their actual technical characteristics they can now be defined primarily in terms of their applicability to the conduct of a flexible response strategy.

While a conscious consideration of the requirements for strategic flexibility may have only been a relatively insignificant factor in the design and development of command and control systems in the 1960s, by at least 1972, the emphasis in the public statements of those officials responsible for command and control developments in the Pentagon had clearly shifted to the justification of existing and proposed programmes in terms of the requirements of strategic flexibility. For example, Defense Department officials have even been careful to stress the flexibility features of the Navy's Sanguine ELF system, which was originally designed to transmit "short, emergency action messages."[1] This readily discernable shift in the importance attached to flexibility in command and control development can to a large extent be explained in terms of a reaction to the correspondingly renewed emphasis on increasing the number of strategic

---

1 Edgar Ulsamer, "C^3: Key to Flexible Deterrence", (Air Force Magazine, July 1974), p 49.

options available to the President which has been manifested at the highest political levels. The statements of President Nixon, the import of the NSC studies on nuclear options, as well as Secretary Schlesinger's public statements concerning U.S. strategic doctrine, all suggest that the Air Force and the Navy ought to respond to the new national policy by concerning themselves with the development of those systems which are necessary for its implementation.

The relationship between national policy and the development of particular systems by the military services is not, however, usually so straight-forward or quite so simple. In the first place, many of the systems required for the implementation of a flexible response strategy had in fact already been developed, largely for reasons not directly related to the issue of strategic flexibility. High level interest in the flexibility doctrine could not be considered a significant factor in <u>their</u> development.

Second, the selective response strategy was by no means new to the Air Force and the Pentagon. As was explained above, the case for strategic flexibility and its implications for command and control had been made throughout the 1960s, although efforts to develop the associated capabilities had been stymied by a lack of interest and a lack of funds. Thus, the renewed emphasis on flexibility in the early 1970s could not be said to have given rise to new command and control concepts or to basically new proposals for specific systems and programmes. What it did do was to provide a "green light" to proceed along lines of development which had hitherto been blocked by a lack of high level support. This aspect of the history of command and control

development illustrates Halperin's more general observation that:

> "...Most policy issues are not new; they have arisen time and again. Organizations have examined the same or similar issues on a number of occasions in the past...Once an issue has been defined and participants have developed their stands, those desiring change are likely to raise the issue when events, as they perceive them either provide opportunities for change heretofore absent or increase the cost of continuing to operate without change."[1]

In the early 1970s, the renewed high level political interest in strategic flexibility in fact provided the opportunities for those participants in the defense policy process who advocated the development of command and control systems required for a flexible employment of the strategic nuclear forces to change the orientation of command and control development from its primary emphasis in the 1960s on insuring the means to retaliate to the present emphasis on enhancing strategic flexibility.

At least one other factor should be considered in explaining this shift in emphasis in command and control development - namely, the technological dimension. In many respects, the technology which was required for developing the command and control systems to perform the functions associated with the flexible response strategy was simply not available in the 1960s. For example, the development of an operational early warning satellite, which has more recently been identified as an important component of a potential attack assessment capability was not successful until 1971. Efforts to develop such a satellite had begun at least as early as 1960, but they had been frustrated with

---

1 Halperin, op.cit., pp 99-100.

technical difficulties which were only resolved by continuing research and development conducted throughout the Sixties. Likewise, the development of an airborne command post which could be equipped with the automatic data processing capabilities which have been considered necessary for providing attack assessment and force retargetting calculations has only been made possible by the development and refinement of the technology involved in the making of miniturized, lightweight electronic components.

In the final analysis, the development of the actual systems which are today closely identified with the performance of the command and control functions required for the implementation of a highly flexible nuclear strategy cannot be considered to have been the result of a conscious, deliberate policy to develop systems for this purpose. On the contrary, the development of these systems was initially intended to serve other purposes. The technical characteristics which were ultimately designed into such systems as the early warning satellite, the SAC Automated Command and Control System, and the Command Data Buffer System, have nevertheless endowed them with the potential for satisfying the command and control requirements for a flexible nuclear response strategy. Furthermore, the renewed emphasis on strategic flexibility which has manifested itself since 1970 has led not only to an emphasis on the flexibility features of existing systems, but has also provided the go-ahead for developing additional systems, such as the Advanced Airborne Command Post, specifically intended to enhance the U.S. capability to implement a selective response strategy. The convergence of new technology, existing capabilities, and a significant shift in

emphasis in U.S. strategic doctrine in the early 1970s has in effect defined the start of a new generation in command and control development.

A Glossary of Acronyms and Abbreviations

AFSATCOM -- Air Force Satellite Communications System

ASW -- Anti-submarine warfare

BMEWS -- Ballistic Missile Early Warning System

DDR&E -- Director, Defense Research and Engineering

DOD -- Department of Defense

ELF -- Extremely low frequency

EMP -- Electromagnetic pulse

ERCS -- Emergency Rocket Communications System

FAA -- Federal Aviation Agency

FBM -- Fleet Ballistic Missile

FOBS -- Fractional Orbital Bombardment System

FY -- Fiscal Year

HF -- High frequency

ICBM -- Intercontinental ballistic missile

JCS -- Joint Chiefs of Staff

JSTPG -- Joint Strategic Target Planning Group

LCC -- Launch control center

LF -- Low Frequency

MIDAS -- Missile Defense Alarm System

NCA -- National Command Authorities

NMCC -- National Military Command Center

NMCS -- National Military Command System

NUDETS -- Nuclear Detection and Reporting System

OTH -- Over-the-horizon radar

PACCS -- Post-Attack Command and Control System

ROCCS -- Regional Operations Control Centers

SAC -- Strategic Air Command

SACCS -- SAC Command and Control System

SAGE -- Semi-Automatic Ground Environment

SIOP -- Single Integrated Operations Plan

SLBM -- Sea-launched ballistic missile

SLFCS -- Survivable Low Frequency Communications System

TRW -- Thompson-Ramo-Wooldridge

UHF -- Ultra-high frequency

USAF -- United States Air Force

VLF -- Very low frequency

WWMCCS -- Worldwide Military Command and Control System

BIBLIOGRAPHY

Books

Acheson, Dean. Present at the Creation. London: Hamish Hamilton, 1970.

Armacost, Michael H. The Politics of Weapons Innovation : The Thor-Jupiter Controversy. New York: Columbia University Press, 1969.

Brodie, Bernard. Strategy in the Missile Age. Princeton: Princeton University Press, 1959.

Brodie, Bernard and Fawn M. From Crossbow to H-Bomb. Bloomington: Indiana University Press, 1973.

Chayes, Abram and Wiesner, Jerome B. (ed.). ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System. New York: The New American Library, 1969.

Deitchman, Seymour J. Limited War and American Defense Policy. Cambridge (Massachusetts): The M.I.T. Press, 1964.

Enthoven, Alain C. and Smith, Wayne K. How Much is Enough?: Shaping the Defense Program, 1961-1969. New York: Harper and Row, 1971.

Fryklund, Richard. 100 Million Lives: Maximum Survival in a Nuclear War. New York: The MacMillan Company, 1962.

Halle, Louis J. The Cold War as History. New York: Harper and Row, Publishers, 1967.

Halperin, Morton H. Bureaucratic Politics and Foreign Policy. Washington, D.C.: The Brookings Institution, 1974.

Halperin, Morton H. Contemporary Military Strategy. (2nd. ed.). London: Faber and Faber, 1972.

Head, Richard G. and Rokke, Ervin J. (ed.). American Defense Policy. (3rd ed.). Baltimore: The Johns Hopkins University, 1973.

Hoopes, Townsend. The Devil and John Foster Dulles. London: Andre Deutsch, Ltd., 1974.

Huntington, Samuel P. The Common Defense. New York: Columbia University Press, 1961.

International Institute of Strategic Studies. The Military Balance, 1974-1975. London, 1974.

Kahn, Herman. On Thermonuclear War. Princeton: Princeton University Press, 1961.

Kaufmann, William W. The McNamara Strategy. New York: Harper and Row, Publishers, 1964.

Kissinger, Henry A. Nuclear Weapons and Foreign Policy. New York: W.W. Norton and Company, Inc., 1969.

Klass, Philip J. Secret Sentries in Space. New York: Random House, 1971.

Knorr, Klaus and Read, Thornton. Limited Strategic War. London: Pall Mall Press, 1962.

Newhouse, John. Cold Dawn: The Story of SALT. New York: Holt, Rinehart and Winston, 1973.

Pfaltagraff, Robert L., Jr. (ed.). Contrasting Approaches to Strategic Arms Control. Lexington: D.C. Heath and Company, 1974.

Quanbeck, Alton H. and Bleckman, Barry M. Strategic Forces: Issues for the Mid-Seventies. Washington, D.C.: The Brookings Institution, 1973.

Quester, George H. Nuclear Diplomacy: The First Twenty-Five Years (2nd ed.). New York: Dunellen, 1973.

Sapolsy, Harvey M. The Polaris System Development: Bureaucratic and Programmatic Success in Government. Cambridge (Massachusetts): Harvard University Press, 1972.

Snyder, Glen H. Deterrence or Defense. Princeton: Princeton University Press, 1961.

Taylor, Maxwell D. The Uncertain Trumpet. New York: Harper and Brothers, Publishers, 1960.

Tsipis, Kasta, et. al. The Future of the Sea-Based Deterrent. Cambridge (Massachusetts): The MIT Press, 1973.

Wohlstetter, Roberta. Pearl Harbor: Warning and Decision. Stanford: Stanford University Press, 1962.

York, Herbert F. Race to Oblivion: A Participant's View of the Arms Race. New York: Simon and Schuster, 1970.

Periodical Articles*

"Additional Warning Satellites Expected," Aviation Week and Space Technology, May 14, 1973.

"Air Force: Across the Spectrum, C & C Capabilities Are Increasing," Armed Forces Management, Vol. 12, No. 10, July 1966.

---

*Not included in this bibliography are several newspaper articles used by the author from the New York Times, the Washington Post, the Washington Evening Star, and the Philadelphia Inquirer. Also not included are several unsigned news items found in the following periodicals : Aerospace Digest International, Armed Forces Management, Aviation Week and Space Technology, Military Review, Ordnance, and Science News Letter.

"Air Force 'L' Systems", Air Force Policy Letter for Commanders (Supplement), No. 9, August 1964.

Alsop, Stewart. "NUDETS- The Paradox of Horror," Saturday Evening Post, Vol. 236, No. 43, December 17, 1963.

Alsop, Stewart. "Our New Strategy: The Alternatives to Total War," The Saturday Evening Post, Vol. 236, No. 43, December 1, 1962.

Baar, James. "New U.S. Command System Coming," Missiles and Rockets, December 4, 1961.

Bergamini, David, "Government by Computers?" The Reporter, August, 17, 1961.

Bergquist, Major General Kenneth P. "Aerospace Command and Control, "Air University Quarterly Review, Vol. XII, No. 3 and 4, Winter-Spring 1960-1961.

Bergquist, Major General Kenneth P. "Crisis in Command," Air Force Magazine, Vol. 43, No. 12, December 1960.

Bestic, Major General John B. "Development of a National Military Command System," Signal, Vol. XVII, No. 7, March 1963.

Bestic, Major General John B. "The National Military Command System," Signal, Vol. XVIII, No. 1, September 1963.

Bestic, Major General John B. "National Military Command System: Decision Instrument for the Chief Executive," Data, Vol. 9, No. 3, March 1964.

Bestic, Major General John B. "NMCS Affords U.S. Full Control and Flexible Response," Data, Vol. 12, No. 1, January 1967.

Bestic, Major General John B. "Prologue to National Survival," Signal, Vol. XVII, No. 3, November, 1962.

Borklund, C.W. "How to Succeed in Spite of Yourself," Armed Forces Management, Vol. 10, No. 10, July 1964.

Borklund, C.W. "National Military Command Control: Problems in Brief ...," Armed Forces Management, Vol. 9, No. 10, July 1963.

Brower, Michael. "Controlled Thermonuclear War," The New Republic, Vol. 147, No. 4-5, July 30, 1962.

Brower, Michael. "Nuclear Strategy of the Kennedy Administration," Bulletin of the Atomic Scientists, Vol. XVIII, No. 8, October 1962.

Burgess, John S. "The Research Frontier: Planning the Design and Development of Electronic Components," Air University Quarterly Review, Vol. XIII, No. 4, Summer 1962.

Burr, Lieutenent Colonel William E. "Centralized Control," Military Review, Vol. XLVI, No. 5, May 1966.

Burt, Lieutenent Colonel Robert L. "Low Frequency Communications-the 487-L System," Signal, Vol. XXII, No. 3, November 1967.

Butz, J.S. "White House Command Post-1966," Air Force Magazine, Vol. 47, No. 4, April 1964.

Cahill, J.J. "Resource Management: A New Slant on C&C," Armed Forces Management, Vol. 9, No. 10, July 1963.

Cameron, Juan. "The Rethinking of U.S. Defense," Fortune, Vol. LXXXVIII, No. 6, December 1973.

"Can Vulnerability Menace Command and Control?" Armed Forces Management, Vol. 15, No. 10, July 1969.

Carter, Barry. "Nuclear Strategy and Nuclear Weapons," Scientific American, Vol. 230, No. 5, May 1974.

Coffey, J.I. "Strategy, Strategic Forces and Arms Control," Orbis, Vol. IX, No. 1, Spring 1965.

"Command and Control History," Signal, Vol. XX, No. 8, April 1966.

"Command and Control and Reorientation to Handle Flexible Response Policy," Missiles and Rockets, March 30, 1964.

"Command and Control Spectrum" JCS to the Battlefield," Armed Forces Management, Vol. 14, No. 10, July 1968.

Command Systems," Signal, Vol. XX, No. 8, April 1966.

"Computers aid Attack Assessment Plan," Aviation Week and Space Technology, February 4, 1974.

"DCA's Starbird: Command Systems Metting 'Survivable Uninterruptable' Goals," Armed Forces Management, Vol. 12, No. 10, July 1966.

"Dr. Fubini Stresses DDR&E's Desire for System Compatability," Data, Vol. 10, No. 2, February 1965.

Edwards, N.P. "What Does Commander Need Is Still Unanswered Question in R&D," Armed Forces Management, Vol. 11, No. 10, July 1965.

"Effectiveness, Responsiveness of National Command System Vital to U.S. Security," Armed Forces Management, Vol. 12, No. 10, July 1966.

"Electronics in Military Decision Making," Interavia, June 1964.

"ESD's O'Niell: Airborne Platforms Herald New Flexibility in Military Information Systems," Armed Forces Management, Vol. 12, No. 10, July 1966.

Evans, Gordon, H. "The New Military Strategy," Current History, Vol, 47, No. 276, August 1964.

Feld, Bernard T. "McNamara on Strategy: A Change in Policy?" The Bulletin of the Atomic Scientists, Vol. XVTV, No. 2, April 1963.

Frisbee, John L. "The Chief Discusses USAF Prospects," Air Force Magazine, Vol. 57, No. 2, February 1974.

Frisbee, John L. "Counterforce Revisited," Air Force Magazine, Vol. 57, No. 2, February 1974.

Frisbee, John L. "Hard Facts and Gossamer Hopes," Air Force Magazine, Vol. 57, No. 4, April 1974.

Frisbee, John L. "USAF's Electronic Revolution," Air Force Magazine, Vol. 54, No. 7, July 1971.

Getler, Michael. "On the Other Hand, Mr. President." Armed Forces Management, Vol. 16 No. 7, April 1970.

Getler, Michael. "President's Personal Interest is the Key Ingredient for Progress," Armed Forces Management, Vol. 16, No. 10, July 1970.

Gettings, Hal. "AF Moves to Avert Command 'Crisis," Missiles and Rockets, October 17, 1960.

Giddings, Colonel (Retired) Ralph L., Jr. "Battle Management for Strategic Weapons Systems," U.S. Naval Institute Proceedings, Vol. 97, No. 1/815, January 1971.

Gilpatrik, Roswell L. "Our Defense Needs : The Long View," Foreign Affairs, Vol. 42, No. 3, April 1964.

Gould, Major General Gordon T. "Air Force: Command and Control-Future Trends," Signal, Vol. XXT, No. 7, March 1967.

Gould, Major General Gordon T. "Command Control & Communications Systems: Yesterday and Today," Signal, Vol. XX, No. 9, May 1966.

Gould, Major General Gordon T. "Computers and Communications in the Information Age," Signal, Vol. XXV, No. 6, February 1971.

Greenwood, Ted and Nacht, Michael L. "The New Nuclear Debate: Sense of Nonsense?" Foreign Affairs, Vol. 52, No. 4, July 1974.

Hagen, Colonel Robert P. "Military Commanders Must Learn the C&C Systems Can Aid Art of Command," Armed Forces Management, Vol. 12, No. 10, July 1966.

Halperin, Morton H. "The 'No Cities' Doctrine,'" The New Republic, Vol. 147, No. 15, October 8, 1962.

Hartsook, E.H. "'Overkill': Theories and Implications," Orbis, Vol. VII, No. 4, Winter 1964.

Herranen, Harry. "Airborne Omaha," Skyline, Vol. 19, No. 2, 1961.

"How Not to Build C&C Systems is Still an Unanswered Question in Defense," Armed Forces Management, Vol. 12, No. 10. July 1966.

Ickle, Fred Charles. "Can Nuclear Deterrence Last Out the Century," Foreign Affairs, Vol. 51, No. 2, January 1973.

"Improvement of the Department of the Air Force Command and Control System," TIG Brief, Vol. XX, No. 11, June 7, 1968.

Intriligator, Michael D. "The Debate over Missile Strategy: Targets and Rates of Fire," Orbis, Vol. XI, No. 4, Winter 1968.

Klare, Michael T. "Making Nuclear War 'Thinkable,'" The Nation, Vol. 218, No. 15, April 13, 1974.

Klass, Philip J. "Early Warning Satellites Seen Operational," Aviation Week and Space Technology, September 20, 1971.

Licklider, J.C.R. "The Hardlook at Software," Armed Forces Management, Vol. 9, No. 10, July 1963.

Loosbrock, John F. "Command and Control for Missiles and Rockets," Air Force and Space Digest, Vol. 43, No. 4, April 1960.

Loosbrock John F. "Counterforce and Mr. McNamara," Air Force and Space Digest, Vol.45, No. 9, September 1962.

Loosbrock, John F. "Strategic Retreat from Reality," Air Force and Space Digest, Vol. 46, No. 1, January 1963.

Luttwak, Edward N. "Nuclear Strategy: The New Debate," Commentary, Vol. 57, No. 4, April 1974.

McGowan, Col. Norman J. "Deputy for Systems Management Has Tech Control over ESD System Program Directors," Data, Vol. 9, No. 3, March, 1964.

McQueen, Lt. Col. Verden. "Total Command and Control Through Computers?" Armed Forces Management, Vol. 9, No. 10, July 1963.

May, Michael M. "Some Advantages of a Counterforce Deterrent," Orbis, Vol. XIV, No. 2, Summer 1970.

Miller, Barry, "U.S. Moves to Upgrade Missile Warning," Aviation Week and Space Technology, Vol. 101, No. 22, December 2, 1974.

Moore, William C. "Counterforce: Facts and Fantasies," Air Force Magazine, Vol. 57, No. 4, April 1974.

Moulton, Harland B. "The McNamara General War Strategy," Orbis, Vol. VIII, No. 2, Summer 1964.

"NMCS: The National Voice of Command," Data, Vol. 11, No. 1, January 1966.

"National Military Command Center: Fast But Loose," Armed Forces Journal International, Vol. 112, No. 3, November 1974.

"Navy: A Theory of Evolution," Armed Forces Management, Vol. 16, No. 10, July 1970.

"Navy Emphasizes Swing Toward Strategic Command and Control," Armed Forces Management, Vol. 15, No. 10, July 1969.

Nicholson, Lieutenant Colonel Clifton L. "Command and Control and the Decision-Making Process," Air University Review, Vol. XV, No. 1, November-December 1963.

O'Neill, Major General John W. "From the Commander," Signal, Vol. XX, No. 8, April 1966.

Page, Esterly C. "The National Military Command System: A Director's View," Signal, Vol. XVII, No. 8, April 1963.

Panofsky, Wolfgang K.H. "The Mutual Hostage Relationship Between America and Russia," Foreign Affairs, Vol. 52, No. 1, October 1973.

Paschall, Major General Lee M. "The Air Force Satellite Communications System," Signal, Vol. XXVIII, No. 7, March 1974.

Paschall, Major General Lee M. "C^3 and the National Strategy." Signal, Vol. XXXVIII, No. 8, April 1974.

Paschall, Major General Lee M. "The Command and Control Revolution," Air Force Magazine, Vol. 56, No. 7, July 1973.

Paschall, Major General Lee M. "Command and Control: Why the Air Force's New Systems Are Revolutionary," Air Force Magazine, Vol. 57, No. 7, July 1974.

Paschall, Major General Lee M. "USAF Command Control and Communications Priorities," Signal, Vol. XXXVII, No. 2, November 1973.

Pfefferkorn, Robert G. "Taylor's Flexible Response Strategy Shifts C&C Perspective," Armed Forces Management, Vol. 9, No. 10, July 1963.

Possony, Stefan T. "The Real Revolution in Warfare: The Computer Impact," Orbis, Vol. XVII, No. 3, Fall 1973.

"Problems Marked Early Satellite Effort," Aviation Week and Space Technology, September 20, 1971.

"The Red Telephone of SAC," Boeing Magazine, Vol. XXVIII, No. 4, July 1958.

Schenk, Peter J. "Decisions, Decisions, Decisions," Air Force and Space Digest, Vol. 44, No. 4, April 1961.

Scoville, Herbert, Jr. "Flexible Madness?" Foreign Policy, No. 14, Spring 1974.

Scoville, Herbert, Jr. "Schlesinger's 'Sufficiency': A New Arms Race Ahead?" The New Republic, Vol. 170, No. 3, January 19, 1974.

"The Search for Effective Command and Control," Armed Forces Management, Vol. 8, No. 10, July 1962.

Sheehan, Captain Brian. "Through the Looking Glass," The Airman, Vol. VIII, No. 7, July 1964.

Slade, Second Lieutenant Ken. "Retargetting," Combat Crew, Vol. XXII, No. 2, February 1971.

Steinhauser, Thomas C. "Command and Control Improvements: On the Front Burner," Armed Forces Journal, Vol. 109, No. 9, May 1972.

Steinhauser, Thomas C. "Winning Team: How the NMCC Works," Armed Forces Journal, Vol. 109, No. 9, May 1972.

Steinkraus, Brigadier General Lawrence W. "Command and Control," Ordnance, Vol. LV, No. 305, March-April, 1971.

"Support Programs Range From the Ocean Floor to Weather Satellites," Armed Forces Management, Vol. 14, No. 7, April 1968.

"Surveillance & Control Systems," Signal, Vol. XX, No. 8, April, 1966.

Terhune, Major General C.H. "Commander of ESD Answers Questions for DATA Readers," Data, Vol. 8, No. 3, March 1963.

Terhune, Major General C.H. "Electronic Systems," Air University Quarterly Review, Vol. XIV, No. 1 and 2, Winter-Spring 1962-1963.

Tibbets, Brigadier General Paul W. "About Our Working National Military Command System," Armed Forces Management, Vol. 10, No. 10, July 1964.

Townsend, Colonel Barry B. "ESD Deputy for Advanced Planning Initiates New Systems," Data, Vol. 9, No. 3, March 1964.

Townsend, David W. "What Hath SACCS Wrought," Combat Crew, Vol. XXII, No. 1, January 1972.

Treatment of Operations-Research Questions in the 1969 Safeguard Debate," Operations Research, Vol. 19, No. 5, September 1971.

Twite, Commander Martin J. "The Impact of ADP on the Naval Strategic Command and Control System," Naval War College Review, Vol. XX, No. 2, September 1967.

Ulsamer, Edgar. "C^3: Key to Flexible Deterrence," Air Force Magazine, Vol. 57, No. 7, July 1974.

Ulsamer, Edgar. "Command and Control Is of Fundamental Importance," Air Force Magazine, Vol. 55, No. 7, July 1972.

Ulsamer, Edgar. "Communications Must not Limit National Strategy," Air Force Magazine, Vol. 56, No. 7, July 1973.

Ulsamer, Edgar. "MX: The Missile System for the Year 2000," Air Force Magazine, Vol. 56, No. 3, March 1973.

Ulsamer, Edgar. "Nuclear-Proof Flying Command Post," Air Force Magazine, Vol. 56, No. 1, January 1973.

Ulsamer, Edgar. "The Pentagon Looks at New Strategic Options," Air Force Magazine, Vol. 57, No. 2, February 1974.

Ulsamer, Edgar. "The Realities of Limited Strategic Options," Air Force Magazine, Vol. 57, No. 7, July 1974.

Ulsamer, Edgar. "Upgrading USAF's ICBMs for the Counterforce Role," Air Force Magazine, Vol. 57, No. 2, February 1974.

Wadsworth, James J. "Counterforce," Saturday Review, Vol. XLV, No. 29, July 28, 1962.

Wagner, J.H. "NMCS: The Command Backup to Counterforce," Armed Forces Management, Vol. 9, No. 10, July 1963.

Walkowitz, Theodore F. "Counterforce Strategy," Air Force and Space Digest, Vol. 38, No. 2, February 1955.

Ward, Chester. "The 'New Myths' and 'Old Realities' of Nuclear War," Orbis, Vol. VIII, No. 2, Summer 1964.

Watson-Watt, Sir Robert. "Radar Defense Today - and Tomorrow," Foreign Affairs, Vol. 32, No. 2, January 1954.

Weiss, George. "Restraining the Data Monster: The Next Step in C^3" Armed Forces Journal, Vol. 108, No. 21, July 5, 1971.

Witze, Claude. "Farewell to Counterforce," Air Force and Space Digest, Vol. 46, No. 2, February 1963.

Wohlman, Major John A. "Computer-Generated Map Data: An Aid to Command and Control," Air University Review, Vol. XIX, No. 2, January-February 1968.

"WWMCCS - World-Wide Military Command and Control System," Commanders Digest, February 14, 1974.

Yale, Colonel Wesley W. "Command and Control in the Grande Armee," Armor, Vol. LXXXVIII, No. 5, September-October 1969.

Zuckerman, Sir Solly. Judgement and Control in Modern Warfare," Foreign Affairs, Vol. 40, No. 2, January 1962.

Zuckert, Eugene M. "Command and Control - Firm Hand and All-Seeing Eye," Air Force and Space Digest, Vol. 48, No. 4, April 1965.

Zystra, Don. "AF Applies Weapons System Concept to Communications," Missiles and Rockets, July 4, 1960.

Government Documents

McNamara, Robert S. "Defense Arrangements of the North Atlantic Community," Department of State Bulletin, Vol. XLVII, No. 1202, July 9, 1962.

U.S. Congress. House of Representatives. Committee on the Armed Services. Inquiry into the U.S.S. Pueblo and EC-121 Plane Incidents, 1969.

U.S. Congress. Senate. Subcommittee on Arms Control, International Law and Organization of the Committee of Foreign Relations. U.S. - U.S.S.R. Strategic Policies. 1974.

U.S. Department of Defense. Annual Report of the Secretary of Defense and the Annual Reports of the Secretary of the Army, the Secretary of the Navy and the Secretary of the Air Force, Fiscal Year 1960. Washington, D.C.: U.S. Government Printing Office, 1961.

(Note: The same reports for fiscal years 1961-1967 were also used in this study but are not separately listed in this bibliography.)

U.S. Department of Defense. "Assistant Secretary of Defense (Telecommunications)." Department of Defense Directive No. 5135.1, January 11, 1972.

U.S. Department of Defense. "Director, Telecommunications and Command and Control Systems." Department of Defense Directive No. 5135.1, January 17, 1974.

U.S. Department of Defense. Report of the Secretary of Defense James R. Schlesinger to the Congress on the FY1975 Defense Budget and FY 1975-1979 Defense Program, March 4, 1974.

U.S. Department of Defense. Report of Secretary of Defense James R. Schlesinger to the Congress on the FY 1976 and Transition Budgets, FY 1977 Authorization Request and FY 1976-1980 Defense Programs, February 5, 1975.

U.S. Department of Defense. Statement of Secretary of Defense Melvin R. Laird Before the House Armed Services Committee on the FY 1973 Defense Budget and FY 1973-1977 Program, February 17, 1972.

U.S. Department of Defense. "Worldwide Command and Control System (WWMCCS)." Department of Defense Directive No. 1500.30, December 2, 1971.

Reports and Papers

Ball, Desmond V. "The Strategic Missile Programme of the Kennedy Administration, 1961-1963," Unpublished PH.D. thesis, Australian National University, 1972.

Carmichael, Colonel Douglas W. "Attack Assessment," Space and Missile Organisation (USAF/AFSC), Los Angeles, California, December 14, 1973. (Unpublished paper)

Dalkey, N.C. Command and Control -- A Glance at the Future. P-2675. Santa Monica: The RAND Corporation, November 1962.

DeWilde, Lieutenant Colonel David A. "A Command and Control System for the NCA: What's Needed?" Report No. 5226. Air War College, Maxwell A.F.B., Alabama, April 1974 (Unpublished paper)

Greenwood, Ted. Reconnaissance, Surveillance and Arms Control. Adelphi Paper No. 88. London: The International Institute For Strategic Studies, June 1972.

Kuck, Major George A. "Nuclear Weapons Induced Electromagnetic Pulse Effects on AF Systems." Air Command and Staff College, Maxwell A.F.B., Alabama, May 31, 1974. (Unpublished paper)

Merkle, Judith A. Command and Control: The Social Implication of Nuclear Defense. New York: General Learning Press, 1971.

Owens, Lieutenant Colonel Frank E. et. al. "Command and Control Systems Evolution and Management in DOD." U.S. Army War College, Carlisle Barracks, Pa., May 1974.

Read, Thornton. Command and Control. Policy Memorandum No. 24, Center of International Studies, Princeton University, June 15, 1961.

Security and Resources Panel of the Scientific Advisory Committee. "Deterrence and Survival in the Nuclear Age." NSC 5724, November 7, 1957.

Tindall, Lieutenant Colonel John B. et. al. A Primer in Strategic Command and Control Communications. Research Report 73-5, U.S. Air Force Academy, Colorado, June 1973.